TROPICAL AGRICULTURE

January to December, 1934.

TRINIDAD:
PRINTED BY THE GOVERNMENT PRINTER,
GOVERNMENT PRINTING OFFICE,
PORT-OF-SPAIN.

1934.

TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XI, No. 1. JANUARY, 1934. PRICE 6d.

CONTENTS.

	PAGE.
Sea Island Cotton	1
A Ginger Manurial Experiment	2
Vernalization	3
A Note on the Vegetative Propagation of Kola	4
The Influence of Time of Cutting on the Growth, Yield and Composition of Elephant Grass (*Pennisetum Purpureum*)	5
Vegetative Propagation	6
Studies in West Indian Soils	7
Banana Diseases	8
The Vegetable Ivory Palm (*Hyphoene ventricosa*)	15
West Indian Notes	16
Reviews	20
Sugar Notes	22
Chemical Notes	23
Trend of the Markets	24

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183.

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

SEA ISLAND COTTON.

DURING the last few years the general position of the Sea Island cotton industry in the British West Indies has been the cause of some concern. Falling prices, the accumulation of unsold stocks of lint, outside competition from other types of cotton and the advance of the artificial silk industry have all contributed to the prevailing unsatisfactory state of affairs. The maintenance of cotton cultivation in some of the northern islands, is, however, so essential to their welfare and the crop is so suited to their climate, that repeated attempts have been made to better the situation. In this connection the Empire Marketing Board championed the industry's welfare early in 1928, and it was largely on account of its efforts and those of St. Vincent and Montserrat that a Conference of Sea Island cotton growers was held in Barbados in 1932. The work of this Conference will chiefly be remembered in that it recommended restriction in production and the formation of a West Indian Sea Island Cotton Association. A further meeting of interested parties was convened in London by the Empire Marketing Board at which the formation of the proposed Association and of branch Associations in the various islands was urged. The latter were actually instituted in Montserrat, St. Kitts, Barbados and Nevis. In Antigua, the Cotton Growers' Association, which had been in operation since 1916, undertook to support a West Indian Cotton Growers' Association. The St. Vincent Chamber of Commerce and Agriculture, which had previously absorbed the local Cotton Growers' Association decided to function as a Cotton Growers' Association in order eventually to join the Central Association. In Anguilla, no Association was formed but it was assumed that the cotton growers of this island would join the St. Kitts' Association.

Steps were next taken to form the Central Association. This was successfully accomplished at the Cotton Conference recently held at the Imperial College of Tropical Agriculture. The formation of this Association—to be known as the "West Indian Sea Island Cotton Association"—undoubtedly represents an important advance and should strengthen considerably the position of this industry in the West Indies.

The objects and rules of the new Association having been adopted it was agreed to regard the proceedings of the Conference as those of a general meeting of the Association. The Association

has thus already functioned and its preliminary work will be found recorded in the Report* of the Conference.

The Association has been constituted as a voluntary body which is to be financed by funds derived from a voluntary levy on the export of lint. The Commissioner of Agriculture has been elected as its first President and the Assistant to the Commissioner as its Secretary and Treasurer. The main object of the Association will be to promote and protect the interests of the British West Indian Sea Island cotton industry. Membership will be of two classes: subscribing and honorary. Subscribing membership is to be open to all organised Sea Island Cotton Growers' Associations in the British West Indies and honorary membership to persons or bodies elected by the Executive Committee of the Association. The questions dealt with at its first meeting included, amongst others, the control of production, the raising of a cess to meet the expenses of the Association, the formation of an Advisory Committee in England, the Association's programme of work for 1934, and legislation.

With regard to the control of production it was agreed to limit the total acreage of Sea Island cotton for 1934 to 5,700 acres and the maximum lint exported to 787,000 lb. In future, no island is to be allowed to export lint from the 1934 planting in excess of the allotted production without the assent of the Association. Moreover, no island is to hold unsold quantities of lint in the United Kingdom and Europe at any one time in excess of one third of its average lint production for the ten-year period, 1922-1931. In view of the limits defined by the above figures, it is of interest to note that from an average of 13,000 acres, calculated over the ten-year period mentioned, the area under Sea Island cotton in the British West Indies fell to about 6,000 acres in 1932 and to 3,600 acres in 1933. Although this drop in acreage can laregly be accounted for by voluntary restriction of production, it serves to illustrate the plight of the industry.

To finance the work of the Association it was considered that a cess of ¾ cent per lb. of lint exported was necessary for the requisite budget but recognising Montserrat's position it was agreed that a cess at the rate of ½ cent per lb. of lint should be levied on cotton exported during 1934, except in the case of cotton grown prior to the 1932-33 crop. It is anticipated, however, that Montserrat may eventually agree to a cess of ¾ cent, in which case this amount will also be paid by all the other islands.

During the Conference Mr. Stockdale spoke on the work of Dr. Barker of the Wool Industries Research Association, who has been investigating possibilities for new outlets for Sea Island cotton. Mention was made of experiments which have been carried out with the object of producing a suitable "Wool-Sea Island Cotton Mixture" for use in the manufacture of an ideal type of yarn for underclothing. Reference was also made to the successful production on an experimental scale of a fabric consisting of 75 per cent. jute and 25 per cent. Sea Island Cotton which it was hoped might be used for wool packs. This research work has so far been done without financial assistance from the West Indies but it was thought that more progress would have been made had such assistance been forthcoming. The Association has accordingly recommended that a sum of £300 should be set aside out of its funds for employing an assistant to Dr. Barker for further research work. The expenditure on this work and on advertising Sea Island cotton in the United Kingdom is to be controlled by an Advisory Committee in England, which it was recommended should be appointed for superintending and advising on the work of the Association in the United Kingdom. This Committee, which the Colonial Office has been asked to form, is to include representatives from the Colonial Office, Montserrat, Antigua, St. Vincent, Barbados, the Empire Cotton Growing Corporation, the British Cotton Association and the West India Committee. Money will also be spent on advertising Sea Island cotton in the West Indies and on other items incurred on behalf of the Association. The measures advocated for the control of production, the restriction of exports, and the imposition of the cess are to be effected by suitable legislation, where necessary.

It will be seen that no time has been lost in devising means for establishing the Sea Island cotton industry on a sounder basis. Its future will, however, depend largely on the measure of support given to the recommendations made. It is generally believed that this will be forthcoming. Moreover, by pooling their interests, Sea Isand cotton producers have indicated their determination to overcome the difficulties of the present situation.

* *West Indian Sea Island Cotton Conference, Trinidad*, 1933. Copies of this Report (price 2*s*.) may be obtained on application to the Commissioner of Agriculture, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

A GINGER MANURIAL EXPERIMENT.

By A. W. R. Joachim and H. A. Pieris.

Manurial experiments were undertaken to determine whether the yields of ginger could be improved. The experimental plot was situated at Siyambalagoda near Peradeniya, and was one-thirtieth acre in extent, of ferruginous, gravelly loam lacking in organic matter and slightly acid in reaction. The lay-out and treatment are described. The results were statistically examined and the following conclusions drawn. Sulphate of potash gave 40 per cent. increase, and a complete fertilizer gave 80 per cent. increase, the odds being 20 to 1 and 100 to 1 respectively against those differences being due to chance. Nitrate of soda and superphosphate gave no significant results.—(*Imperial Agricultural Bureaux, Hort. Abs.*, Vol. III, No. 3, Ab. 403.)

VERNALIZATION.

NOTE.—Vernalization is a subject that has attracted much attention recently in the literature of agricultural science, and the claims made for it as a technical advance are so strong that some account of the process and underlying principles should be of interest to many agriculturists. The work has hitherto been concerned with the conditions and needs of temperate agriculture, but it is not improbable, if the theories there elaborated are confirmed, that complementary applications will be possible in the tropics. The original papers on vernalization are in Russian, but a review of the principles underlying the process was published by A. A. Sapelin in 1932 in "Der Züchter" (1), a German publication devoted to breeding. The Imperial Bureau of Plant Genetics has recently issued a summarised account of the experimental work in English (2). These sources have been freely used in the following note.

THE phenomenon of photoperiodism in plants, first investigated by Garner and Allard about fourteen years ago, is by this time widely recognised. Experience has shown that certain plants such as the cereals, oats and wheat, beet and onion require a length of day above a critical period of about 14 hours before they will go into the reproductive phase, while other plants, such as maize, soybean, yam and sweet potato under similar conditions remain in the vegetative phase and only fruit when the length of day is below the critical period. This naturally led to the belief that fruiting was in some unknown way dependent on the diurnal alternation of light and dark.

From recent investigations the staff of the Ukrainian Institute for Genetics and Plant Breeding at Odessa hold that this belief is not correct and that there is no necessity for photoperiodism to ensure fruiting. Lyssenko, with whose name the new process is chiefly connected, states that "Photoperiodism exists, but not in the nature of plants so much as in the nature of the regions where there occurs the daily alternation of day and night". They claim to have shown that "the time necessary for the completion of the processes conditioning reproduction of the plant is independent of its size and age, but is primarily determined by its genotypical peculiarities and by its environment. Thus whether a plant is in the state of a germinating seed in which the seed coat is not yet broken or whether it is already well developed vegetatively the transition to the reproductive stage requires the influence of the same factors acting for the same time. In other words: the processes determining the change from the vegetative to the reproductive phase in plants, may occur not only in the growing plant, but also in the germinating seed".

The transition to the reproductive stage is not only independent of the size and age of the plant but also has no connection with the growth of the plant. The two processes of growth and reproduction may take place independently of one another but under suitable external conditions both may occur simultaneously. The fact that the process of preparation of a plant towards reproduction may occur in the embryo and may be separated in time from the growth of the plant makes possible the practical application of the method. The Russian term for the process is "Jarovizatzia", which has recently been translated into English as "Vernalization". By its application seed can be treated so that it will produce plants fruiting at a pre-determined time. The process has been aptly described as "early sowing which is carried out in the granary". Seed is germinated and growth is artificially stopped before it has reached a stage at which subsequent handling might be detrimental to it. The material is then subjected to appropriate conditions for affecting reproduction, after which it is sown.

The appropriate conditions vary widely and must be determined experimentally, not only for each species, but also for each variety of a single species, to obtain the best results. For wheat, vernalization is obtained by keeping the germinated seed with a moisture content of 50 per cent. at a temperature of 3°C. for twelve to fifteen days. For tropical short day crops such as maize and soyabean, vernalization is obtained by keeping the germinated seed at about 25°C. for ten to fifteen days in complete darkness.

The method had been most carefully worked out in Russia for spring wheats such as are grown on the Ukrainian Steppes. The chief characteristic of such wheats is their early flowering which is essential if they are to withstand damage by high summer temperature. Vernalization has enabled varieties which normally bear too late to set any crop to be grown, in some cases with a considerably greater yield than the standard varieties. Last year vernalization trials were carried out at Odessa on 6,300 samples of wheats.

Vernalization of the short day sub-tropical and tropical plants has not yet been investigated so thoroughly as that of the wheats. It has been found that darkness, humidity, temperature and aeration must all be controlled. The degree of moisture of the germinated seedlings requires careful attention during the process or otherwise growth proceeds so rapidly that the overgrown seeds cannot be sown. Plants from vernalized seed can be grown under any condition of illumination. Their ability to utilise longer periods of daylight is advantageous in that an increased production of dry matter becomes possible in addition to the acceleration of reproduction.

(1) *Der Züchter*, Vol. IV, No. 6, pp. 147-51, 1932. Berlin.

(2) Vernalization or Lyssenko's Method for the Pre-Treatment of Seed. R. O. Whyte, PH.D. and P. S. Hudson, PH.D. Bull. No. 9 of the *Imperial Bureau of Plant Genetics*, Cambridge. Price 2*s*. 6*d*.

Many important commercial crops depend on tuber formation and attempts have been made to apply the principle of vernalization to such crops as exemplified by the potato. Long days favour vegetative development and flowering while short days favour tuber formation in the potato. Lyssenko's explanation of this is that short day tuber formation is due to the inability of the plant to utilise photosynthetic products for continued vegetative development and flowering and the consequent diversion of such products to storage organs. Under long day conditions these products are utilised for development and flowering, but when fruiting is completed, the plant continues to assimilate and to use the products of assimilation for tuber formation. To increase tuber formation, it is therefore necessary to get the fruiting cycle over as quickly as possible. This stage can be aided by exposing the tubers to light before planting. Under the appropriate conditions of temperature and humidity, tubers can be kept in continuous light for 20 to 30 days without growth becoming so active as to endanger the young shoots during planting.

The fundamental idea underlying vernalization is that the processes of growth, by which is meant gain in weight and size, and of development, or the transition from one phase to another, are two distinct phenomena taking place independently of but not necessarily antagonistic to, one another. The processes determining the change from the vegetative to the reproductive phase may take place at any time during the life of the plant, even in the germinated seed. Vernalization is in effect "the elimination of the effect of natural geographical and climatic factors limiting the introduction into field cultivation of any desired plant".

The process is too new as yet to give any result of its commercial application. That it will enable heavier yielding wheats to be grown on the Ukrainian Steppes seems certain. It is also being applied to forage crops, where it enables an earlier first cut to be obtained. The chief function of the process according to Lyssenko, is the speeding up of plant breeding. Meanwhile, until successful new varieties have been introduced, vernalization is expected to be directly and chiefly responsible for increased yields.

A NOTE ON THE VEGETATIVE PROPAGATION OF KOLA (*Cola acuminata*) BY SOFTWOOD CUTTINGS.

In exploring the rooting behaviour of different species of cacao, trials were also made with the allied genus, Kola. The plants available were young seedlings, aged about four years, growing in rather poor soil on an unshaded College plot. Vigorous terminal and lateral shoots were used, which had just matured from a "flush", *i.e.*, mature, but new wood was taken for cuttings, which were made about four inches in length. Apart from removing some of the lower ones, the leaves were not trimmed. Two media were tried, a non-calcareous sand (from the Arena forest reserve), and the calcareous beach-sand used in cacao propagation. The latter only was satisfactory. In this sand the Kola cuttings callused within a week, and most of them rooted in from six to ten weeks. The batches were necessarily small, and were insufficient to justify a percentage rooting figure. However, the cuttings kept healthy in the propagator and a reasonable proportionate rooting was indicated. In all the rooted cuttings a single stout root emerged from the stem, just above the lowest point of the oblique cut (*see* Diagram), and grew downwards at an angle of between 45° and 60° to the vertical, afterwards becoming truly vertical. Laterals were formed and the main root became hard and corky in the older parts. When the main root was two to three inches long the cutting was potted in a mixture of sand and leaf mould and gradually hardened off. A more rapid hardening than with cacao cuttings appeared possible.

E. E. P.

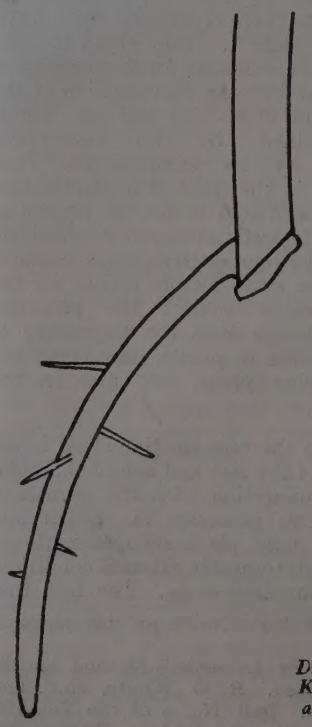


Diagram of rooted stem of Kola, shewing main root and lateral roots.

THE INFLUENCE OF TIME OF CUTTING ON THE GROWTH, YIELD AND COMPOSITION OF ELEPHANT GRASS (*Pennisetum purpureum*).

By

D. D. Paterson,

Imperial College of Tropical Agriculture.

[*The following note is a resumé of a paper published in the "Journal of Agricultural Science," Vol. XXIII, No. 4, in which a detailed account is given of the results of a fodder grass experiment carried out on the College Farm in 1932. Certain aspects of this research are of practical importance wherever Elephant Grass is grown as a forage crop, and this précis is intended to bring such information to the notice of tropical farmers, who may be chiefly interested in the application of the results to field practice.*]

Possibly the most outstanding feature of the insular tropical climate is its entire lack of any great variation throughout the year, with the result that there is no closed season during which plant growth is inhibited. This has produced the somewhat unusual system of livestock maintenance in which the stock is fed almost wholly on fresh cut green forage, obtained either from the natural herbage growing on waste lands or from daily cuttings taken from a perennial fodder grass under cultivation. The yield of natural herbage or of fodder grass may be anything from 20-100 tons per acre per annum, yet there is very little information available regarding the feeding quality of the different grasses or the cutting rotation that will give the stockman both high yields and the maximum nutritive value per ton. Recent research in England has shown that both the stage at which fodder grasses are cut and the particular season alter considerably the composition of the forage, particularly as regards the protein content. The object of the present experiment was to ascertain under Trinidad conditions, the effect of three different cutting rotations on the yield and quality of a cultivated crop of Elephant Grass. The cutting rotations selected were as follows :—

Series A. Cut every 4 weeks.
Series B. Cut every 8 weeks.
Series C. Cut every 12 weeks.

After planting, the Elephant Grass was given four months in which to get thoroughly established, and, at the end of this period, a stand of approximately 100 per cent. was obtained using a spacing of three feet between rows and two feet between plants in the row. The whole field was then mown on 14th January, 1932, and the experimental records were taken from that date to 15th December, when the final cutting of the three series synchronised. On the rotations adopted, this gave yield data for twelve cuttings of Series A, six of Series B and four of Series C. For each series and each cutting, representative samples were selected for chemical analysis and were analysed in the Chemistry Department of the College, by kind favour of Professor Hardy and Mr. Duthie.

Study of the yield data showed that, within the twelve-week cutting rotation, the longer the interval between crops, the higher the yield per acre of both green herbage and dry matter. Over the eleven month period, the total yields of the individual series were as follows :—

	Green Fodder.		Dry Matter.	
	Yield in tons per acre.	Percentage of Series C.	Yield in tons per acre.	Percentage of Series C.
Series A	24.1	56.5	3.39	39.2
Series B	35.7	83.7	5.68	65.4
Series C	42.7	100.0	8.70	100.0

The average height of the tillers when cut was one and a half to two feet in Series A, three to three and a half feet in Series B, and four and a half to five feet in Series C.

In the yields of both herbage and dry matter there is a marked rise from Series A to Series C. Furthermore, field observations showed that cropping as frequently as every four weeks affects adversely the vitality of the plant, produces a smaller root system and a less vigorous stool, and ultimately leads to a high mortality in the individual stools. Two consecutive good crops from Series A do not appear to be practicable, as the first cutting saps the ratooning capacity of the plant, and the four week interval to the succeeding crop does not provide sufficient length of time for the plant to recover its vitality. This phenomenon of a drop in yield after a heavy flush is a normal one; in England, for example, it is generally found in ordinary farm practice that if a heavy hay crop is procured, a good aftermath rarely occurs.

The chemical analyses revealed a definite increase from A to B to C in dry matter and crude fibre percentage, and an equally distinct fall in the protein and mineral percentage. The relative figures for protein are given in the table on page 6.

In nutritive value, the average grade of green fodder from the experimental area is roughly equivalent to medium quality meadow hay ready for harvest. The Elephant Grass is rather lower than the hay in crude protein. When compared with pasturage in England on a monthly cropping rotation, even the least mature cuts of Elephant

Grass from Series A gave a very low protein percentage. Analysis of very young shoots of Elephant Grass showed that, in protein percentage, they resemble similar pasture cuts in England. The more rapid growth in the tropical fodder appears to produce a much quicker drop in the protein percentage, so as to make it impossible to obtain, from Elephant Grass grown on a field scale, a fodder with a close nutritive ratio.

	Protein Percentage.		Total Yield of Protein.	
	In Dry Matter.	Expressed as a per-cent. of Series A.	Tons per Acre.	Expressed as a per-cent. of Series A.
Series A	9.85	100	.34	100
Series B	7.43	82	.42	123.5
Series C	6.09	62	.52	153.0

Therefore, Series C gives much the highest yield of protein per acre: the produce from this series is considerably lower in protein percentage than that from A or B, but the greater bulk of green fodder and of dry matter from the longer cutting rotation adopted more than compensates for this.

The rainfall incidence in Trinidad is the seasonal factor which has most influence on plant growth. In all series, growth rate was at its maximum in May and June when the rainfall was highest. A definite correlation is shown to exist between the monthly precipitation and the composition of the herbage. The dry matter, the crude protein and the ash percentage all vary inversely with the rainfall. In the wet months there is a fall in the percentage of these three constituents. The crude fibre percentage on the other hand, tends to increase during the wet season. As the productivity in Elephant Grass is at its highest in the heavy rainfall months when the soil is copiously supplied with moisture, this seasonal fluctuation in the composition of the grass means that, when the crop is growing most vigorously, the nutritive value per unit weight of herbage is at its lowest.

The mineral content of the produce from all series appears to be adequate, except in regard to calcium. This is possibly on the low side for rations fed to young animals. There is a distinct fall in the percentage of P_2O_5, CaO and Silica-free Ash from Series A to C. This decrease in minerals in the more mature foliage is a normal phenomenon.

In the present experiment with Elephant Grass, the three-month cropping rotation has distinct advantages over the more frequent cutting systems. It gives a very much higher yield of green fodder and of crude protein per acre. The decrease in nutritive value when compared with younger herbage is not excessive, and the rise in crude fibre percentage is not sufficiently great to lower unduly the digestibility of the produce when fed to tropical stock. The difference in digestibility would be even less if the older produce was chaffed before being fed to the stock. The three-month rotation favours healthiness and longevity in the plant, and produces a type of stool with a much larger root system which, in turn, makes for greater productivity and renders the crop less susceptible to weed competition. From the economic aspect, a much smaller area of land will supply the required bulk of fodder, and as a relatively small number of the stools will need to be used daily, the cuttings should be completed in a shorter time.

Although these results are both instructive and conclusive, it should be remembered that they are based on a single experiment of relatively short duration and that they only touch the fringe of the various problems that await solution. While Elephant Grass at present is one of the most popular cultivated fodder grasses in Trinidad, it has shown itself to be highly susceptible to fungal attack from *Helminthosporium* sp. This appears to occur in epidemic form only at fairly wide intervals—three to five years—but once the grass is heavily infected, it produces very little yield and ultimately dies off. It is possible, therefore, that other fodder grasses such as Uba Cane (*Saccharum*) or Guatemala Grass (*Tripsacum laxum*) which are immune to this fungal disease will in future be cultivated in preference. These grasses will almost certainly react in an entirely different manner to different cutting rotations and to seasonal variations. Changes in soil type or manurial treatment will influence considerably both the yield and the composition of all the grasses at various stages of growth. In consequence, a larger scale experiment has now been started in which six varieties of fodder grass suited to Trinidad conditions are under observation. The cutting rotation has been extended so as to provide yield data and material for analysis from plants at a later stage of growth, in some series after flowering and seeding have taken place. It is hoped thus to be able to ascertain in the near future how far the provisional findings of the original experiment are of general application, and to compare the results for the different fodder grasses and the different seasons.

Vegetative Propagation.—T. H. Parsons.

Various methods of propagation by cuttings, marcotting (gooteeing), layering, inarching and grafting under tropical conditions are described. An ingenious method of keeping the bandage around a marcotted branch moist in dry weather with little attention is illustrated. A section of bamboo filled with water is suspended above the marcot. The bottom of the bamboo is pierced to admit a thick string, the other end of which is wrapped round the bandage. The water in the bamboo slowly but continuously passes down the string ensuring a constant supply of moisture to the part under treatment.—(*Imperial Agricultural Bureaux, Hort. Abs.*, Vol. III, No. 3, Ab. 381.)

STUDIES IN WEST INDIAN SOILS.

Cacao Soils of Trinidad.

THE series of Supplements to *Tropical Agriculture*, describing the results of field and laboratory studies of West Indian soils, which form a part of the programme of work of the Chemistry and Soils Department of the College, was referred to in the last issue of *Tropical Agriculture* (Vol. X, No. 12, p. 345). A further addition to the series (No. VII), issued in October, 1933, under the authorship of J. A. McDonald, F. Hardy and G. Rodriguez, deals with the cacao soils of the Montserrat District of Trinidad, which occupies a large part of the Central Range area of the island. The soil survey of this region by the profile method was begun in October, 1928, by F. Hardy, aided by C. G. Akhurst and R. G. H. Wilshaw (Post-Graduate Students), and certain special aspects of the soil work were later dealt with by G. Griffith and by A. R. Foster (Post-Graduate Students). The greater part of the detailed field mapping was performed in 1931 and 1932 by J. A. McDonald, Soil Chemist under the Cacao Research Scheme. The laboratory examination of representative soil samples (some 820 samples in all, taken from 85 soil profiles), was prosecuted by the laboratory staff of the College Soils Department, under G. Rodriguez, Analyst. For purposes of comparison, 54 further soil samples, representing five profiles, were examined from forest lands adjacent to the cacao area. Full analytical data for all these samples are tabulated at the end of the paper; they include values for index of texture, reaction, calcium carbonate, organic matter and nitrogen contents, carbon/nitrogen ratio, available phosphate, total available (water-soluble) nutrients, and rate of solution of nutrients. In addition, available potash contents for the top six-inch layers of soil are also included.

The cacao soils of the Montserrat District of Trinidad are derived from sedimentary rocks of Pliocene and Miocene age, and from their alluvial derivatives. The parent materials vary considerably in mineralogical and chemical composition. The better soils are derived from sedimentary rocks which appear to have been formed under shallow water conditions favourable to the fixation of potash and phosphate in secondary minerals, such as glauconite. Calcareous matter occurs, often in abundance, in these sediments. Such are the rocks from which the famous Chocolate Soil and the better sorts of Brasso Sand, Brasso Clay and Talparo Clay Soils have originated. Certain of the poorer types of soil have been formed from sedimentary rocks that contain abundant gypsum (calcium sulphate), and the analytical results indicate that, where the concentration of sulphate in the surface soil layers is appreciable, the productivity of these soils may be very low. The prospects of ameliorating such gypseous soils (for example, certain of the Brasso Clay, Talparo Clay and Charuma Clay Soils) are extremely doubtful, and it is evident that considerable areas of cacao land occupied by them will prove unprofitable when prices are low. This aspect is amply demonstrated by the results of an economic survey of the Montserrat District cacao estates, undertaken by Professor C. Y. Shephard and his Post-Graduate Students, and briefly summarised, with his permission, in a section of the article written by R. S. Ball.

Comparison of "good" and "bad" cacao soils in the Montserrat District has revealed the following contrasted features: firstly, the "good" soils (cacao yields, over 8 bags of 165 lb. of dried fermented cacao per 1,000 pickets) contain in their top six-inch layers *more organic matter* of a definitely *higher carbon/nitrogen ratio* than the "bad" soils (yield, 8 bags or less, per 1,000); and secondly, the "good" soils contain significantly greater amounts of *available phosphate* than the "bad" soils. These results apply, not only to the Montserrat District cacao soils of Trinidad, but also to soils of quite different origin in Grenada and in Tobago (*see* Part IV and Part III of the series of Studies in West Indian Soils). They may be of general application in all parts of the world where commercial cacao is grown.

Of the other factors concerned in the productivity of the cacao soils of the Montserrat District, *soil reaction* (pH value) seems not in itself to be a differentiating factor, except in-so-far as it is a reflection of the lime status of the soil, and hence of its water relations and its degree of aeration as decided by tilth. The magnitudes of the *electrical conductivity* values of water extracts of the "good" and the "bad" soils are often significantly different, indicating both a better nutrient status of the "good" soils, and the presence of harmful amounts of gypsum in the "bad". Finally, *available potash*, contrary perhaps to expectation, seems *not* invariably to be significantly greater in the "good" soils than in the "bad", although the sandy types of "good" soil usually do contain greater amounts of available potash.

The general indications of the fertility studies of the Montserrat District cacao soils support the contentions that the nutrient status of cacao soils (other things being equal) is the main factor deciding productivity, and that, in this connection, the question of adequate *balance* in the nitrogen, phosphate and potash supplies in the soil is fundamental and really important. In future manurial plot experiments in the field, as well as in some of those that have already been laid down in Trinidad and Grenada, this point of view ought to be particularly stressed and carefully examined. In problems of practical manuring, the specific needs of the soil itself should receive first consideration, since both maximum plant growth and fruit production depend on an adequate nutrient status of the soil, as decided by its intrinsic nature and composition, and this may be imparted or attained only by the addition of suitable proportionate amounts of the various nutrient elements, rather than by the universal application of a "standard" mixed manure of arbitrary composition.

BANANA DISEASES.

VI. The Nature and Occurrence of Pitting Disease and Fruit Spots.

BY

C. W. WARDLAW,

Low Temperature Station, Imperial College of Tropical Agriculture.

Introduction.

During recent years pitting disease and fruit spotting in general have received an increasing amount of attention in banana literature. The former, first reported by Tomkins (5) as a cause of serious wastage in Brazilian cargoes, consists in the presence of considerable numbers of spots or pits localised principally on the finger-stalks and cushions of the two or three proximal or uppermost hands. These pits are not apparent when the fruit is reaped but develop during storage. At first small, they extend during cold storage and ripening, and are ultimately responsible for a considerable amount of finger-dropping. Pitting disease was investigated by Tomkins (5) on fruit arriving in England, and by Wardlaw and McGuire in Brazil (8). During 1933 it was observed for the first time on Trinidad fruit and was accordingly, in view of its commercial importance, made the subject of special study.

The information available on the subject of banana fruit spots is scanty. Leaving aside the more obvious and easily diagnosed spots (anthracnose) caused by *Gloeosporium musarum* and the special type of infection known as "freckle," caused by *Macrophoma musae* in Australasia, little information is available regarding the several minute spots which may be observed distributed generally over the surface of fruits. Small spots on several varieties, with which different fungi were associated, were described by Wardlaw and McGuire in 1929 and 1930 (6, 7). Deighton (1) has described a fruit spot in Sierra Leone with a species of *Pestalozzia* in association. Black pits or spots on banana fruits in Italian Somaliland have been referred by Petri (4) to *Helminthosporium torulosum*. Curzi found *Gloeosporium musarum*, *Stachylidium theobromae* and species of *Fusarium* associated with the spots. As a rule such spotting ranks only as a minor cause of wastage and may indeed be entirely without economic significance though of mycological interest. Recent reports from the extensive Caribbean banana lands, however, show that fruit spotting may, under certain circumstances, acquire considerable economic importance. Thus according to Johnston (2) and Johnston and Slocum (3)* a disease, described as "the fruit spot" and attributed to physiological causes, is present on Gros Michel bananas in Jamaica†, Central and South America.

In this paper an account of some detailed investigations of pitting disease and fruit spots encountered in Trinidad is set out.

Pitting Disease.

From typical pits or spots Tomkins (5) isolated a species of *Pestalozzia* on a large number of occasions, but was unable to reproduce the disease in inoculation experiments. From spots which had become enlarged during ripening, species of *Gloeosporium* and *Fusarium* were isolated but, though capable of rotting banana tissue, these were obviously present in a secondary capacity. Tomkins came to the conclusion that it could not be said from examination of bunches in England, how or when spotting originated, but suggested that it was probably of plantation origin, and that its incidence was to some extent influenced by the position of the large flower bract; the need for fuller investigation in the field was also indicated.

As the result of investigations conducted in Brazil (8) on the Cavendish, Giant Fig and Silk varieties, it was ascertained that the majority of typical pits or spots on finger-stalks, cushions and main-stalks yielded the fungus *Piricularia grisea* (Cke.) Sacc. in pure culture, provided the isolations were made at a sufficiently early stage. In older infections, when secondary organisms have gained access, there is a danger that the original pathogen may not be obtained as it is slow-growing and liable to be over-run by other organisms.

During recent storage trials at the College Low Temperature Station (9) pitting disease has been observed for the first time, three varieties, the Dwarf, Cavendish or Governor, the Giant Governor and Gros Michel being affected. As observed in Trinidad on the first two varieties, the disease compares closely with previous descriptions, the rather deeply sunken spots or pits being chiefly present on the cushions and finger-stalks of the uppermost hands (Fig. 1) and on the main-stalk in linear or seriate groups. A number of small round spots 2-4 mm. in diameter may also be scattered over the upper surface of the fingers of the top and second hand. While some of these spots are definitely associated with pitting disease, others are due to different organisms. Such scattered infections are dealt with separately under "spotting diseases".

So far, pitting disease has shown some localisation in its distribution, being present on bunches of the Giant Governor and Governor obtained from Maqueripe and on the Governor variety from the College Farm, but absent on this

* Information through the courtesy of the United Fruit Company, Boston.

† References to a spotting of Gros Michel fruits, believed to be in the nature of a physiological malady, may also be sought in recent Annual Reports of the Department of Agriculture, Jamaica.

variety grown at Woodford Lodge and the Agricultural Experiment Station. Only in occasional bunches have infections been sufficiently abundant and severe as to cause serious finger-dropping.

The occurrence of this disease on the Gros Michel is of some interest. Here the disease is present in a very mild form and the minute pits or spots only become perceptible on yellow fruit as final maturity is being approached, Fig. 2.

Table 1 shows the incidence of infections on removal of different lots of fruit in one storage trial from the cold chamber.

Table 1.

Variety.	Locality.	(i) Total percentage bunches showing some pitting.	(ii) Percentage bunches showing severe pitting.
Governor ..	Maquerape ..	50	13
Giant Governor	Maquerape ..	24	6
Governor ..	Agricultural Experiment Station	0	0
Governor ..	College Farm	26	2
Governor ..	Woodford Lodge	0	0

(i) This refers to any evidence of pitting on the top-most hands and main-stalk, *i.e.* from 3-4 pits to severe pitting.

(ii) This refers to bunches where pitting would ultimately be responsible for some finger-stalk rot and finger-dropping. These figures are not in addition to, but are included in column (i) above.

Table 2.

Variety and Locality.	Percentage.	First Trial.	Second Trial.	Third Trial.	Fourth Trial.
Giant Governor	Total percentage showing some pitting disease	24	52	13	5
Maquerape	Percentage with severe pitting disease	6	10	0	0
Governor	Total percentage showing some pitting disease	26	—	—	5
College Farm	Percentage with severe pitting disease	2	—	—	0

In Table 2 the extent of pitting disease in four consecutive trials is shown. These covered a period of approximately four and a half months. Fruit reaped for the first two trials had been grown during more or less continuous wet weather: fruit used in the third and fourth trials had developed during the dry season. Although incomplete, the data suggest a direct relationship between the incidence of pitting disease and weather conditions and lend support to the contention that infections are of field origin but remain latent or dormant till the fruit has been held in storage for some time.

Isolation of Fungi.

Fungi were isolated from typical pits by stripping off the epidermal and superficial layers and picking up infected tissue on a sterile scalpel from the innermost infected region. These fragments when planted on various standard media mostly yielded fungal cultures; in the older pits, secondary bacteria were sometimes in evidence.

In Table 3 the fungi associated with typical specimens of pitting disease are shown.

Table 3.

FUNGI ASSOCIATED WITH PITTING DISEASE (FROM 157 ISOLATIONS).

Variety and Locality.	Piricularia grisea.	Gloeosporium musarum.	Helminthosporium torulosum.	Fusarium spp.	Other Fungi.
Governor (Maquerape)	13	2	0	4	10
Governor (College Farm)	41	0	6	10	3
Giant Governor (Maquerape)	45	4	2	5	12
Total ..	99	6	8	19	25

From a typical specimen of pitting disease in the Gros Michel variety the following record was obtained:

	Number of isolations.
Piricularia grisea	6
Cephalosporium sp. ..	1
Fusarium semitectum ..	2

The fact that *Piricularia grisea*, almost without exception the most slow-growing organism isolated, was obtained with such preponderating frequency, affords strong circumstantial evidence of its causal relation to pitting disease. These records lend confirmation to the diagnosis reached during investigations in Brazil (8).

In Table 4 the growth rates of several of the fungi are recorded on a medium frequently used during isolations; similar results were obtained on plain agar and other culture media.

Table 4.

Diameter of colony on Malt Extract agar, after 5 days; in cms.

Fusarium sp.	4.6
Fusarium sp.	4.5
Fusarium sp.	4.7
Sphaeronema sp.	1.5
Helminthosporium torulosum	3.9
Acrothecium lunatum ..	5.2
Gloeosporium musarum	
Strain 1	5.1
Strain 2	4.7
Strain 3	5.5
Strain 4	3.8
Glomerella cingulata ..	5.3
Piricularia grisea	1.8
Piricularia grisea (from Brazil)	1.7

The presence of *Helminthosporium torulosum* on main-stalks, cushions and fingers, and its prevalence as a fungus of fruit spots (*see* below) suggest that it may also be included as a subsidiary organism of pitting disease.

Other fungi, chiefly associated with pitting disease in a secondary capacity, include *Gloeosporium musarum* Cke. & Massee, *Glomerella cingulata* (Stonem.) Sp. & V. Schrenk, *Acrothecium lunatum* Wakker, *Stachylidium theobromae* Turc., *Pestalozzia leprogena* Speg., *Nigrospora oryzae* (B. & Br.) Petch, *Fusarium semitectum* Berk. & Rav., *F. sambucinum* Fck., other species of *Fusarium*, *Sporormia minima* Auersw., *Clasterosporium maydicum* Sacc. (group), *Verticillium* spp., *Phomopsis* sp., *Sphaeronema* sp., and unidentified fungi. These organisms quickly follow the primary pathogen and are largely responsible for the enlargement of the pits and for subsequent finger-dropping.

Transition leaves and bracts, from which infections on the uppermost hands are thought to be derived by the downward movement of spore-laden water, were collected for investigation. After being held for a few days in a moist chamber, abundant superficial growths of *Piricularia grisea* were again obtained, thus supporting the hypothesis that the localisation of infections on the upper part of the bunch may be referred to this original source of infection. Among other fungi which develop on transition leaves and bracts are *Helminthosporium torulosum* (Syd.) Ashby, *Stachylidium theobromae* Turc., *Gloeosporium musarum* Cke. & Massee, *Nigrospora oryzae* (B. & Br.) Petch, *Chlamydomyces palmarum* (Cke.) Mason, *Haplographium atrobrunneum* (Cke.) Sacc., and species of *Verticillium*, *Fusarium* and other fungi.

Dissemination of the Pathogen and Remedial Measures.

One of the outstanding features of pitting disease is the curious localisation of infections on the cushions and finger-stalks of the proximal or uppermost hands (*i.e.*, of the bunch as it hangs on the plant). The fact that the transition leaves and bracts, which immediately overhang the bunch, also become infected by the pathogen at an early stage, led to the hypothesis that this localisation of infections could be attributed to the downward movement of spore-laden water from this source (8)—a point of view amply confirmed by these studies undertaken in Trinidad. Nevertheless, the remedial measure suggested, namely that this disease may be avoided by the simple practice of removing transition leaves and bracts before they become infected by wind-borne spores, has apparently not proved efficacious during the wet season. So far as can be ascertained through correspondence, pitting disease in Brazilian fruit, grown under conditions of high rainfall, has not been appreciably diminished even though a careful programme of bract-removal was carried out. This rather unexpected result indicates the need for further investigation.

In mycological examinations of bracts in Trinidad, undertaken during the unusually long rainy season,* it was found that some of these carried a very large number of separate *Piricularia* infections, indicating that under certain weather conditions this fungus is widely and abundantly disseminated by wind, while the prevailing high humidities permit of rapid spore germination and penetration of plant tissues. Where air-borne spores are so abundant, the fruits may become directly infected, quite apart from spores washed down from the transition leaves and bracts. The occurrence of isolated spots over the surface of fruits, also caused by *Piricularia grisea*, may be taken as lending support to this suggestion. This, however, does not explain the localisation of infections round the cushions and finger-stalks of the uppermost hands only, unless it be assumed that the spores collect there after being washed down and along the curved surface of the fingers.

Thus while the treatment suggested should prove efficacious in the drier seasons, it is liable to be defeated by the combination of prevailing moist conditions and an abundant spore dispersal. To achieve a substantial reduction in pitting disease in continuously moist weather, therefore, it may be necessary to resort to protective measures. In large scale operations, and particularly with a crop like the banana, this will prove a rather difficult problem, especially during the season of heavy rainfall.

In view of the considerable wastage usually sustained in the large proximal or top hand (bottom hand in Trade terminology) as a result of mechanical injury during transport and bulk stowage, there is the further economic question as to what extent it is worth treating this hand for pitting disease since it may so frequently be down-graded or rejected from other causes. In illustration of this aspect some experiences with the Governor variety may be quoted. Some plants were grown on rather poor soil but with suitable fertilisers and good bunches were obtained. These, however, proved very subject to mechanical injury.

* 1932-1933.

Thus, in one consignment, on removal from cold storage after 16 days, although 29 per cent. of the bunches showed evidence of some pitting (of which only 10 per cent. would have caused finger-dropping) at least 83 per cent. of the bunches showed mechanical injury to the finger-stalks of the top and second hand. Thus the wastage, as determined by commercial criteria, would be referable mainly to the mechanical damage sustained during handling. In other words, the preponderance of such injuries would practically obliterate the good effect of any significant reduction in pitting disease achieved by the application of control measures in the plantation.

Fruit Spots: Previous Investigations.

So far the principal type of fruit spot, other than typical anthracnose (*Gloeosporium musarum*), of real economic importance, is that described by Johnston (2) and Johnston and Slocum (3) as "the banana fruit spot". It is stated that this disease may occur at certain seasons in any of the banana-producing areas of the Caribbean region. These spots are typically small, roundish and usually dark coloured. Three types or stages have been described: (i) in the field, spots may develop on young fruits and persist to maturity; (ii) spots may also appear after bunches are "three-quarters full" (*i.e.* English grade of fruit); these spots increase in size on the green fruit after reaping; (iii) when green or turning fruits are maintained under unsuitable ripening conditions, spots also develop.

This type of spotting is most commonly found in the autumn or winter months, that is, when temperature and evaporation are lowest and rainfall and atmospheric humidity highest. Although the poorer grades of fruit are affected most, the disease may also occur to some extent on good fruit.

The investigators are of the opinion that this disease is not caused by insects or fungi, although mycelium may often be present later in a secondary capacity. From the evidence accumulated it is thought that the spotting is physiological in nature, being indirectly due to weather conditions, particularly low evaporation; it may also be directly correlated with lack of available nitrates in the soil. The poorer quality fruit from water-logged or poor land is generally much more subject to spotting than fruit from well drained areas of good soil.

In some instances spots may be in evidence prior to reaping, but as a rule the serious economic aspect of this disease is due to the great increase in spotting during transport and ripening. It is believed that the relative amount of spotting can be reduced in the field by improving the yields from good areas rather than from average or poor areas, and by improving growing conditions. On the market the quality of fruit, in the matter of spotting disease, can be improved by suitable selection on the farms, at the wharves and in domestic ports, and also by providing optimum conditions during transport and subsequently for speedy ripening.

In passing it may be noted that the illustrations in Johnston's paper show individual bananas or even a whole bunch to be spotted to such an extent as to be unsightly.

Deighton (1) states that Canary bananas (*Musa cavendishii*) in Sierra Leone are sometimes subject to spotting during wet seasons. A species of *Pestalozzia* has been found in association. The fruit may be attacked when half ripe. The spots appear as circular water-soaked areas, measuring up to 2 mm. in diameter, with a central spot which later develops into a dark sunken area with a narrow water-soaked margin. These areas may then coalesce. As the fruit matures the spots lengthen out into transverse streaks and the larger areas into longitudinal cracks with grey margins.

In former investigations in Trinidad (6, 7) a few instances of spotting diseases came under observation. Of these the most important was a profuse spotting of the Hybrid I.C.1 developed during storage and ripening. From the characteristic dark circular infections *Piricularia grisea* was frequently isolated. From somewhat similar spots very occasionally observed on the Gros Michel during storage and ripening, *Piricularia grisea*, *Helminthosporium torulosum*, *Gloeosporium musarum* and *Phomopsis* sp. were isolated. From occasional black spots, 1-1.5 cm. diameter, on this variety, *Pestalozzia leprogena* was isolated, while other spots yielded *Botryodiplodia theobromae*. Isolated spots occasionally encountered on the Governor or Cavendish variety yielded cultures of *Gloeosporium musarum* and *Botryodiplodia theobromae*.

Trinidad Fruit Spots.

With a view to obtaining more detailed information on the subject of fruit spots, bunches of several varieties were carefully inspected in the field, after reaping, during cold storage at 53°F. and subsequently during ripening at 70°F.

Under Trinidad conditions, fruits of several varieties, after close inspection at the time of reaping, have proved to be quite free from spotting. On the other hand, various small, slightly-sunken dark spots, distributed over the surface of the fruit, have occasionally been observed towards the end of the usual period in cold storage, *i.e.*, 16 to 18 days. Although there was no visible sign of infection at the time of reaping, there seems little doubt that the original infections were of plantation origin. The development of these latent infections was slow at 53°F. and on transference to the ripening room at 70°F. the spots only became slightly larger, Fig. 3. So far, ripe fruits of the Gros Michel, Giant Governor, and Trinidad Governor varieties have seldom been sufficiently spotted as to be unsightly, while destruction of the flesh by the inward extension of the spots has not been observed. The occasional bunches showing severe finger-spotting have usually proved abnormal in their general storage behaviour.

As examples of fruit spots came to hand during storage trials, isolations were carried out as described in an earlier Section. In Table 5 an analysis is given of the fungi isolated from typical spots.

Table 5.

FUNGI ASSOCIATED WITH FRUIT SPOTS (258 ISOLATIONS).

Variety.	Piricularia grisea.	Helminthosporium torulosum.	Gloeosporium musarum.	Fusarium spp.	Other Fungi.
Cavendish ..	62	80	30	9	23
Gros Michel ..	9	20	17	4	4
Total ..	71	100	47	13	27

In general it will be noted that the several small fruit spots yielded a fungal flora similar to that isolated from pits on finger-stalks and cushions; in fact many of the fruit spots are undoubtedly identical in origin and appearance with typical pitting disease. In both the Cavendish and Gros Michel varieties, *Helminthosporium torulosum Piricularia grisea* and *Gloeosporium musarum* may be accepted as primary causes of fruit spotting. As a rule, these fungi were isolated from spots which bear a close resemblance to the physiological fruit spot described by Johnston, individual spots being small roundish, sunken, and dark brown or black in colour, Fig. 3. In spots, from which *P. grisea* and *H. torulosum* were afterwards isolated, small variations were noted: some were exceedingly minute, 1 mm. in diameter or less whilst others ranged from 3-6 mm. in diameter; again some were sunken and brown in colour, with a sharply defined margin, whereas in others the dark coloured spot had a watery margin; other spots were purely superficial or very slightly sunken with a sooty appearance and a slight tendency to spread Fig. 3, V.

In general, Trinidad fruit spots are of scanty occurrence and widely distributed over the fruit, usually on the exposed upper side. Johnston's illustrations of the physiological fruit spot, on the other hand, show fruits affected by a profusion of small and sometimes closely grouped spots.

An instance of very severe spotting on the Dwarf Cavendish variety came to hand in October, 1933, the profusion of infections being no doubt related to the prolonged rainy season. In some bunches, ripened at tropical temperatures without previous cold storage, every hand throughout the length of the bunch showed a large number of small spots or pits both on the finger-stalks and over the upper surface of the fruits. Against the yellow skin these were of conspicuous appearance, Fig. 5. Of 44 cultures isolated from spots, 42 proved to be *Piricularia grisea*, one *Phomopsis* sp. and one *Gloeosporium musarum*. A consignment of 12 bunches, "¾-full", was taken into cold storage and maintained at 53°F. for 16 days with subsequent transference to 70°F. On removal from cold storage, many of the bunches, still green, were found to be profusely infected, every hand showing a number of small spots. As ripening at 70°F. proceeded, the spots gradually extended so that fruits were rendered very unsightly, Fig. 6. Such observations indicate that *Piricularia grisea* may, under conditions favourable to its development, be responsible for very considerable wastage.

The frequent association of *Gloeosporium musarum* with fruit spots was also demonstrated in these studies. In the Cavendish variety this fungus was sometimes isolated from spots similar to those caused by *P. grisea*, from various large spots and from slightly sunken brown spots on mature fruit (typical anthracnose). In one specimen of yellow Cavendish fruit, a common strain of *G. musarum* was consistently isolated from minute pinkish-brown irregular scar-like spots, Fig. 3, III. In the Gros Michel variety, *G. musarum* was frequently obtained from small brown spots indistinguishable from those caused by *P. grisea* or *H. torulosum*. Some of these *Gloeosporium* strains yielded the perfect ascomycetous stage, *Glomerella cingulata* (Stonem.) Spauld. & von Schrenk.

The characteristic brown mottling or freckling which develops, particulatly on the Cavendish variety during the later stages of ripening, Fig. 4, was examined with a view to determining to what extent this is purely physiological and associated with final maturity. As the mottled areas are very shallow, attempts to isolate organisms by stripping off the skin proved rather unsuccessful. In some instances it could be determined that some of the larger mottled patches were due to shallow penetration by *G. musarum*; on the other hand much of the mottling appears to be purely physiological in nature.

Not all fruit spots yielded fungi. As a rule about 75 per cent. of the pieces of diseased tissue planted in sterilised media yielded cultures. Failure to secure organisms is attributed to technical difficulties in dealing with very small spots or to the use of over-hot needles and scalpels.

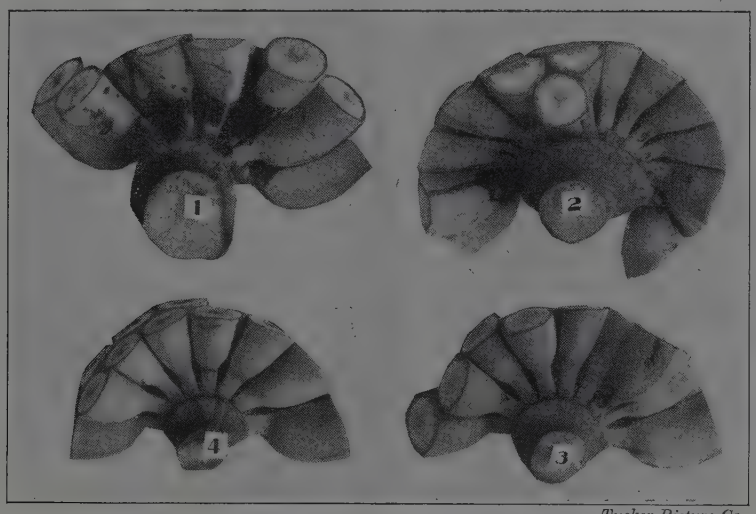
On the whole, the evidence from this series of isolations may be accepted as demonstrating conclusively that the spotting associated with the Cavendish and Gros Michel banana in Trinidad is due to the parasitic activities of several different organisms.

It is possible that spotting may sometimes be associated in the first instance with the activity of sucking insects. Although fruit is frequently severely punctured by insects, spots are usually confined to the topmost side of exposed fingers and rarely occur on the lower or protected areas. In short their distribution is suggestive of typical wind dissemination or of the downward movement of spore-laden water from leaves or bracts.

The fungi associated with fruit spots in a primary or secondary capacity are as follows: *Piricularia grisea* (Cke.) Sacc.; *Helminthosporium torulosum* (Syd.) Ashby; *Gloeosporium musarum* Cke. & Massee; *Glomerella cingulata* (Stonem.) Spauld. & V. Schrenk; *Vermicularia capsici* Syd. (group);

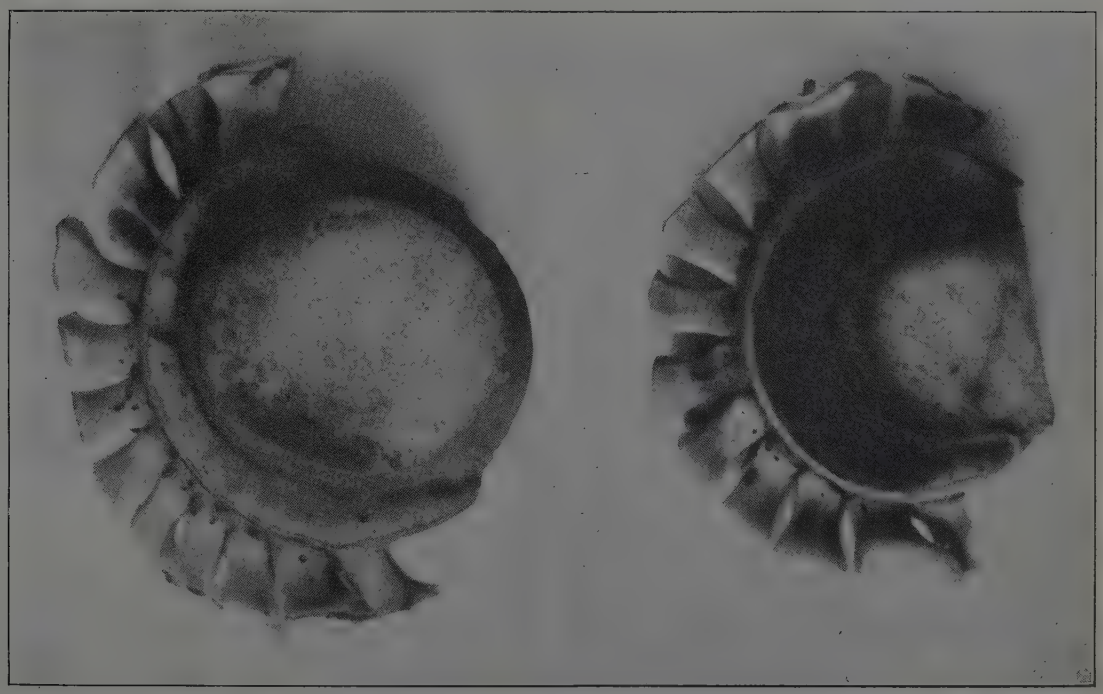
BANANA DISEASES.

VI.—THE NATURE AND OCCURRENCE OF PITTING DISEASE AND FRUIT SPOTS.



Tucker Picture Co.

FIG. 1.—*Pitting disease on the Dwarf Cavendish variety (hands labelled in order of their occurrence): Severe pitting is evident on the first* (1) *and second hands* (2); *it is slight on the third* (3) *and absent from the fourth* (4).

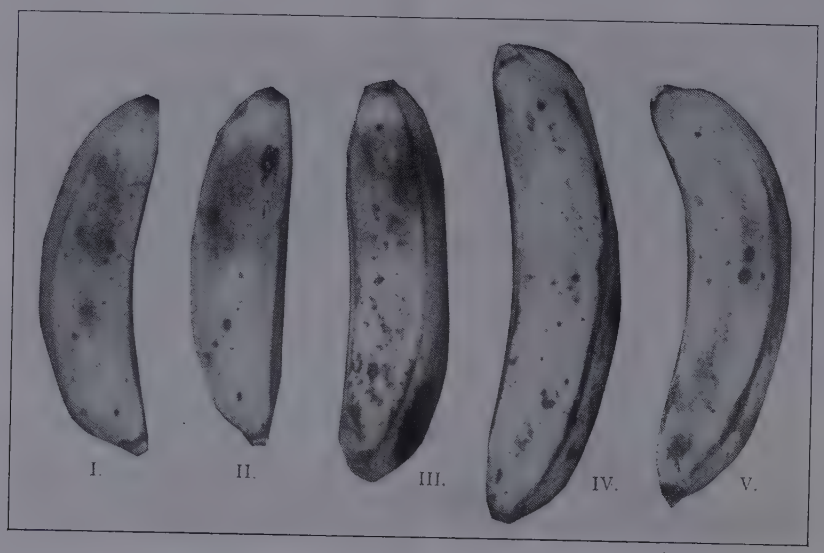


Tucker Picture Co.

FIG. 2.—*Pitting disease on the Gros Michel variety: Only small pits are in evidence even when the fruit has reached final maturity.*

BANANA DISEASES.

VI.—THE NATURE AND OCCURRENCE OF PITTING DISEASE AND FRUIT SPOTS.



Tucker Picture Co.

FIG. 3.—*Scattered fruit spots on the Cavendish variety.*

Tucker Picture Co.

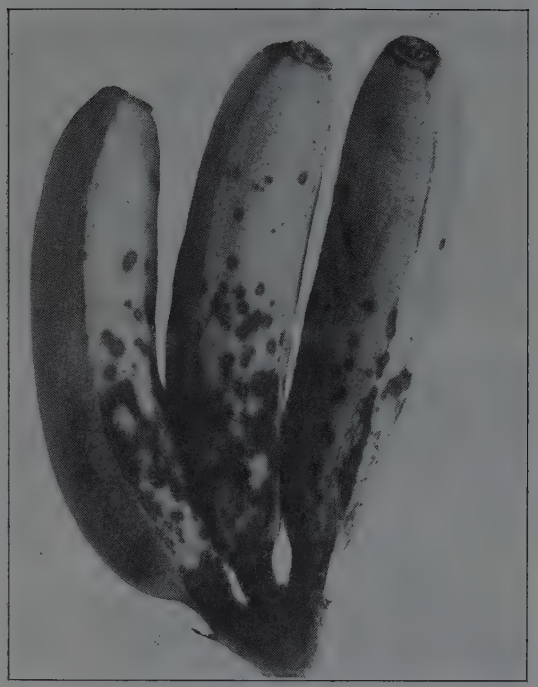
FIG. 4.—*Late maturity freckling of Cavendish fruit.*

BANANA DISEASES.

VI.—THE NATURE AND OCCURRENCE OF PITTING DISEASE AND FRUIT SPOTS.

Tucker Picture Co.

FIG. 5.—*Spotting developed on the Dwarf Cavendish variety ripened at tropical temperatures without previous cold storage.*



F. W. Urich.

FIG. 6.—*Spotting developed on the Dwarf Cavendish variety on removal from cold storage.*

BANANA DISEASES.

VII.—NOTES ON BANANA LEAF DISEASES IN TRINIDAD.

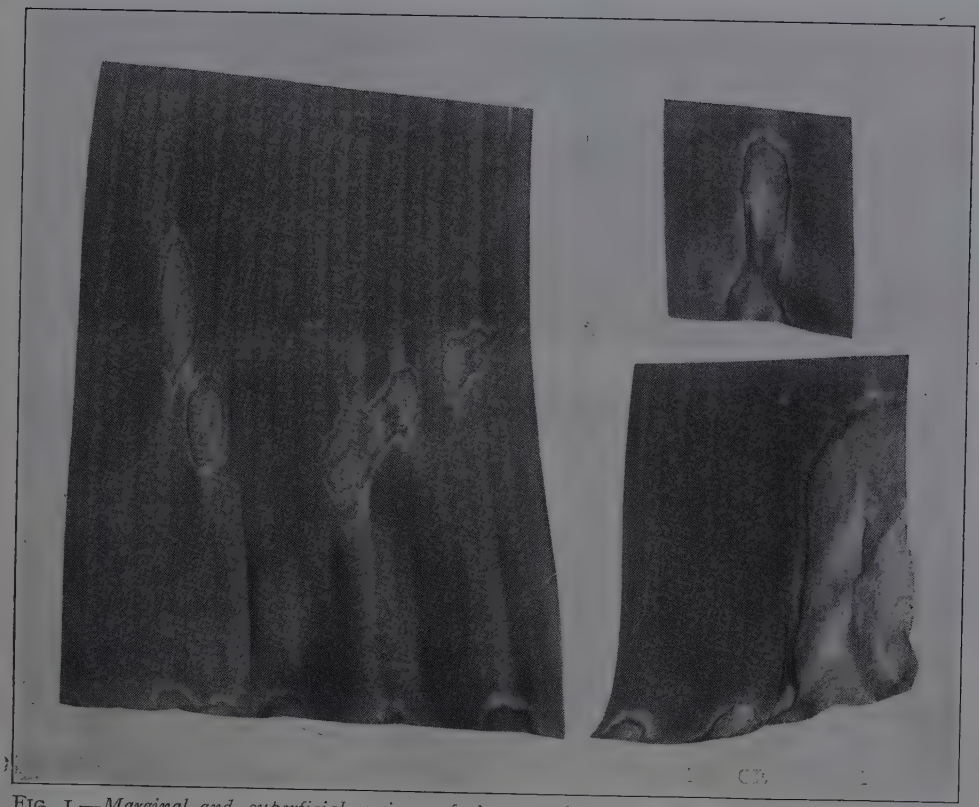


FIG. 1.—*Marginal and superficial regions of decay on leaves of the Cavendish variety caused by Cordana musae (Zimm.) Höhn.*

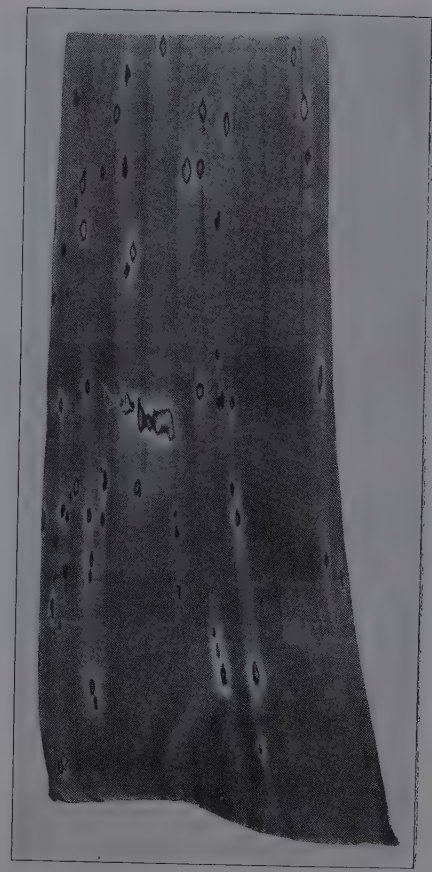


FIG. 2.—*Abundant spotting on leaves of the Cavendish variety caused by Cordana musae (Zimm.) Höhn.*

Fusarium succisae (Schroet.) Sacc.; *F. sambucinum* Fck.; *Verticillium* spp.; *Cephalosporium* sp.; *Nigrospora oryzae* (B. & Br.) Petch; *Papularia sphaerosperma* (Pers.) V. Höhn.; *Acrothecium lunatum* Wakker; *Hormodendron cladosporioides* (Fresen.) Sacc.; *Stachylidium theobromae* Turc.; *Sporormia minima* Auersw.; *Hypomyces ipomoeae* (Hallst.) Wr.; *Pseudoplea ?trifolii* (Rostr.) Petrak.; *Coniothyrium concentricum* (group); *Botryodiplodia theobromae* Pat.; *Sclerochaete* sp.; *Phomopsis* sp.; *Sphaeronema* sp.; *Pestalozzia leprogena* Speg.; *Trichoderma* sp. and unidentified fungi.

Summary.

1. An account is given of the occurrence of pitting and spotting diseases in Trinidad.

2. Typical pitting disease, localised chiefly on the finger-stalks and cushions of the proximal hands, occurs on the Giant Governor and Dwarf Cavendish varieties; a mild and economically unimportant form of the disease has also been observed on the Gros Michel.

3. From an extensive series of isolations, it has been shown that *Piricularia grisea* (Cke.) Sacc. is the principal fungus associated with pits.

4. The origin of pitting disease and the possibility of controlling it under different weather conditions are discussed.

5. In a brief outline of the literature on banana fruit spots, it is indicated that, according to different investigators, some of these have been referred to physiological causes and some to fungal agency.

6. Mycological examination of Trinidad fruit spots indicates that these are of fungal origin and can be referred to *Piricularia grisea* (Cke.) Sacc., *Helminthosporium torulosum* (Syd.) Ashby, *Gloeosporium musarum* Cke. & Massee and other fungi.

7. Under Trinidad conditions these spots are usually of scanty occurrence and are economically unimportant. Occasionally, however, severe spotting may be observed in the Cavendish variety.

In conclusion, the writer wishes to record his indebtedness to Mr. S. F. Ashby and Mr. E. W. Mason of the Imperial Mycological Institute for their unstinted assistance with verifications and identifications.

References.

1. Deighton, F. C.: Mycological Section.—*Ann. Rept. Lands and Forests Dept.*, Sierra Leone for the year 1931.
2. Johnston, J. R.: The Fruit Spot of the Banana. *Res. Dept. United Fruit Co.*, Boston, Mass., Bull. 43, 1932.
3. Johnston, J. R. & Slocum A. H.: The Banana Fruit Spot and its Control. *Res. Dept. United Fruit Co.*, Boston, Mass., Bull. 41, 1932.
4. Petri, L.: *Boll. R. Staz. Veg., N.S.*, XII, 1932.
5. Tomkins, R. G.: Wastage in Banana Transport. *Tropical Agriculture*, VIII, No. 10, 1931, pp. 255-264.
6. Wardlaw, C. W. & McGuire, L. P.: Transport and Storage of Bananas with special reference to Chilling. *E.M.B. Report*, No. 45, 1931.
7. Wardlaw, C. W. & McGuire, L. P.: Control of Wastage in Bananas with Special Reference to Time and Temperature Factors. *E.M.B. Report*, No. 60, 1932.
8. Wardlaw, C. W. & McGuire, L. P.: Pitting Disease of Bananas. Its Nature and Control. *Tropical Agriculture*, IX, No. 6, pp. 193-195, 1932.
9. Wardlaw, C. W. & McGuire, L. P.: Banana Storage. An account of recent investigations into the storage behaviour of several varieties. *Tropical Agriculture*, X, No. 12, 1933, (also *E.M.B. Report* No. 72, 1933).

BANANA DISEASES.

VII.—Notes on Banana Leaf Diseases in Trinidad.

BY

C. W. WARDLAW.

Introduction.

A not inconsiderable number of fungi have been recorded, either in a primary or secondary capacity, in association with banana leaf diseases. Of the several diseases, *Cercospora* leaf spot (Sigatoka Disease) is undoubtedly of greatest economic importance. This, however, though fairly widely distributed in the Indo-Malayan and Australian regions, has not so far been recorded in the New World. Other diseases, which by destruction of the leaf tissue, may assume a greater or lesser significance in the well-being of the plant as a whole, are referable to species of *Helminthosporium*, *Macrophoma*, *Cordana*, *Gloeosporium*, *Mycosphaerella*, &c.

From time to time most varieties of banana in Trinidad are subject to some kind of leaf-spotting, blemishing or disease, in the production of which a number of different organisms are involved.

Methods of Isolating Fungi Adopted.

Specimens of leaf-spots and marginal blemishes were collected from different localities and the isolation of associated fungi carried out using the following methods:

(1) The infected leaf surface was superficially sterilised by being wiped with a piece of cotton-wool soaked in methylated spirits. The leaf sample was then enclosed in a moist desiccator and the outgrowing fungi examined and taken into artificial culture.

(2) Scrapings from unsterilised spots were added to melted tubes of culture medium and the organisms present collected by the poured-plate method.

(3) Pieces of diseased leaf were sterilised superficially as in (1). The material was then cut into small squares (2 mm. x 2 mm.) each of which was dipped in spirit, flamed and planted in plates of culture medium.

(4) Unsterilised pieces of infected leaf were placed in moist desiccators and the outgrowing mycelium picked off and taken into artificial culture.

Numerous isolations of fungi were readily obtained by all four methods.

Isolations from the Cavendish.

On leaves of the Cavendish banana (Trinidad Governor) growing in the Arena forest reserve and in the College variety plot, small black spots of the type described by Ashby (1) were occasionally observed. The larger lenticular spots on the same material were of a pale brown colour with a darker brown colouration at the periphery; the latter abutted on a characteristic bright yellow marginal zone. A concentric zonation was sometimes present. Some of the spots were noted as having a darker smoky-brown appearance, both kinds of leaf-spot occurring in the same group of plants. The type of marginal decay present consisted in wedge-shaped areas of pale to medium brown colour tapering from the margin inwards.

Black spots. From the dark smoky brown or black spots *Helminthosporium torulosum* (Syd.) Ashby was consistently isolated, sometimes accompanied by *Pestalozzia leprogena* Speg., *Nigrospora oryzae* (B. & Br.) Petch, *Acrothecium lunatum* Wakker, *Fusarium semitectum* Berk. & Rav. This is in close agreement with Ashby's observations in Jamaica, and this type of infection may accordingly be referred to his "black-spot" disease.

Ashby's description of the external symptoms of this disease on the Gros Michel is as follows:

The earliest stage of attack is marked by the appearance of pin point round black spots on the main nerves of the leaf blade; they increase in size and become lenticular in the direction of the nerve. The spots are often surrounded by a narrow bright yellow band passing sharply into the normal green of the leaf. They are most noticeable on the outer half of the blade. As the disease advances dry pale brown areas extend from the largest spots fanwise to the edge of the blade so that the spot lies at the apex of a wedge of dry or drying tissue. Later the wedges unite and may give rise to a broad zone of dry tissue running completely round the outer half of the blade.

In Jamaica this disease is not apparently associated with any subnormal condition of suckers or roots, but at the same time hyphae could not be observed in the dead brown tissue of young spots (1). From older spots three fungi were usually obtained, *Helminthosporium torulosum* (Syd.) Ashby (*Cercospora musarum* Ashby), *Pestalozzia fuscescens*, var *sacchari*, *Nigrospora oryzae* (*Acremoniella occulta*). Ashby regards *Helminthosporium torulosum* as responsible for the worst aspects of the disease but the sterility of young spots suggests that the way is first prepared for fungal attack by some other undetermined factor. In subsequent investigations in Bermuda, Ogilvie (3) consistently isolated this fungus from pin-point black spots, and also obtained conidia in abundance on their surface by placing affected leaves in moist chambers for a few days. Healthy leaves wounded at the margin and inoculated developed typical diseased areas in the course of a month. This investigator has also remarked that during the winter months in Bermuda, and under other unfavourable cultural conditions, dead areas appear on the leaves which are difficult to distinguish from those caused by *H. torulosum*—a conclusion with which the present writer is in agreement.

Cordana spots. The paler spots and wedge-shaped marginal infections referred to above and frequently observed in Trinidad support a considerable fungal flora but *Helminthosporium torulosum* was not isolated by any of the four methods. Among others, the following organisms were obtained: *Cordana musae* (Zimm.) Höhn. (*Scolecotrichum musae* Zimm.); *Nigrospora oryzae* (B. & Br.) Petch; *Hypomyces ipomoeae* (Hallst.) Wollenw.; *Aspergillus versicolor* (Vuill.) Tiraboschi; *Fusarium culmorum* (W.G. Sm.) Sacc.; *Phomopsis* sp.; *Acrothecium lunatum*; *Periconia* sp.; *Melanconium* sp.; *Paecilomyces* (Bainier) sp.

Spots and marginal infections on the Gros Michel banana from the same areas yielded the following: *Cordana musae*, *Nigrospora oryzae*, *Pestalozzia leprogena*, *Aspergillus* sp., *Phomopsis* sp.

Leaves collected from a plantation of Cavendish bananas at Arima showed two types of infection (1) characteristic lenticular pale brown spots with a dark periphery and yellow margin and a moderately distinct zonation and (2) marginal infections; these were consistently semi-circular in outline, Fig. 1. Young marginal infections were dark brown to black in colour while older ones were dry, zoned and of a pale brown colour with a darker margin and a bright yellow layer in contact with the normal green tissue. The following fungi were isolated: *Cordana musae*; *Nigrospora oryzae*; *Hormodendron cladosporioides* (Fresen.) Sacc.; *Pestalozzia leprogena*; *Aspergillus niger* Van Tieg.; *Aspergillus luchuensis* Inui; *Fusarium semitectum*; *Fusarium* sp.; *Glomerella cingulata* (Stonem.) Sp. & V. Schrenk; *Glomerella* sp.; *Phomopsis* sp.; *Stigmella* sp. (? *S. sacchari* Speg.); *Sphaeroderma* sp.; *Sphaeronema* sp. This material on examination with a hand-lens showed numerous outgrowing conidiophores, which proved to be those of *Cordana musae*. The presence of this fungus along the extreme margins of spots and also over the entire infected surface suggests that it is the active parasite.

Lenticular leaf-spots of the type described above on the Cavendish banana from other localities consistently yielded a similar fungal flora, *Cordana musae* being the most common and conspicuous organism present.

During the rainy season (in 1933) some Dwarf Cavendish plants in the Maqueripe district were observed showing a profusion of small dark spots, Fig. 2, which again were caused by *Cordana musae*.

Reference to the relevant literature and personal observations indicate that *Cordana musae* is a widely distributed fungus, responsible in many instances for the spotting and marginal infections present on the leaves of different banana varieties. This disease has been described by Bunting and Dade (2) in the Gold Coast as "leaf blotch". It has also been recorded by Simmonds (4) in Queensland, Ceylon and the Indo-Malayan region generally as yellow leaf spot (*Scolecotrichum musae*). It is also present in Brazil (5).

Occasional specimens of *Helotium musicola* Speg. have been observed on the leaves of the Cavendish variety.

Isolations from the Lacatan Variety.

In the Lacatan variety growing in the College grounds, characteristic medium-brown areas of decay, either at the leaf margin or distributed irregularly over the surface, have sometimes been observed, usually on debilitated plants. The following fungi were obtained: *Nigrospora oryzae*; *Sporodesmium bakeri* Syd.; *Fusarium culmorum*; *Fusarium semitectum*; *Gloeosporium musarum*; *Acrothecium lunatum*. *Nigrospora oryzae* was most in evidence in these isolations.

Not infrequently older leaf blemishes appear to be of a compound nature, involving two or more different types of infection which have merged into one another.

Leaf Diseases in Debilitated Plants.

Ashby has described an unhealthy condition of the Gros Michel leaf associated with a Blackhead disease of the sucker developed under adverse soil conditions. The leaves appear unhealthy both in drought and protracted rain, and a brown, dry zone extends inwards from the edge of the blade or the leaf turns pale and yellowish and becomes susceptible to attack by weak parasites like *Cladosporium*, *Dendryphium* and *Nigrospora*. These produce large pale dry spots and wedges or brown flecks (the latter possibly caused by a spinning mite, *Tetranychus* sp.). Similar leaf infections of debilitated plants in Trinidad have also yielded a number of weakly parasitic fungi, notably *Nigrospora oryzae*.

Speckling or Mottling.

A characteristic leaf mottling or speckling consisting of minute brown specks is of very frequent occurrence in some parts of Trinidad, every plant showing areas of the leaf affected, sometimes in localised patches only, at other times over the entire surface. In a preliminary microscopic examination of hand-sections, the tissue in the mottled region was observed to be necrosed and invaded by the hyphae of several fungi. By using the four methods of isolation the following organisms were obtained: (1) in the Cavendish—*Nigrospora oryzae*, *Fusarium* spp., *Stachylidium* sp., and unidentified fungi; (2) Gros Michel—*Nigrospora oryzae*, *Gloeosporium musarum*; (3) Lacatan—*Nigrospora oryzae*, *Penicillium* sp., *Gloeosporium* sp.

This characteristic mottling has been observed on the following varieties: Gros Michel, Cavendish, Lacatan, Congo, and Silk Fig. The same or a similar leaf malady has been observed by Ashby (1) and Ogilvie (3). More recently Simmonds (4) has described this disease in some detail from material observed in Queensland. McLennan and Hoëtte (6) have recently described two new species of *Nigrospora*, *N. Musae* and *N. Canescens*, associated with Speckled leaves in Australia. The precise manner in which the speckled areas are developed is not definitely known.

Bibliography.

1. Ashby, S. F.: Banana Diseases in Jamaica.—*Bull. Dept. Agric.*, Jamaica. New Series, Vol. II, No. 6, 1913.
2. Bunting, R. H. & Dade, H. A.: Gold Coast Plant Diseases.—*Waterlow and Sons, Ltd.*, London.
3. Ogilvie, L.: "Black-tip". A Finger-tip disease of the Chinese Banana in Bermuda.—*Phytopath.*, Vol. XVIII, No. 6, 1928.
4. Simmonds, J. H.: Banana Leaf Spot. Progress Report.—*Queensland Agric. Jour.* XXXIX, 1, 1933.
5. Wardlaw, C. W. & McGuire, L. P.: Cultivation and Diseases of the Banana in Brazil.—*Tropical Agriculture*, X, 1933.
6. McLennan, E. I. and Hoette, S.: *Nigrospora Musae* n. sp. and its connexion with "Squirter" Disease in Bananas. Commonw. of Australia, *Counc. for Sci. and Ind. Res., Bull. No.* 75, 1933.

THE VEGETABLE IVORY PALM

(*Hyphoene ventricosa*).

According to G. M. McGregor (*Rhodesia Agric. Journ.* XXX, 1933), the main habitat of this palm is the Ngami Flats of the Wankie district, though it is found in other parts of Rhodesia. The soil is shallow and badly drained, the ground being covered with depressions and small mounds. It is on the slopes of both of these that the ivory palm is found. The palms are dioecious. The fruits are borne on spadices of which there are usually five per tree arising from the axils of the lower leaves, the average number of fruits being 450 per tree. The fruit is the size of a tennis ball and has a spongy casing which is eaten by natives. Within this is an extremely tough covering of fibrous texture, hard and difficult to open. This contains the ivory or seed. The ivory is soft in the green fruit but hardens on opening. It is hollow and contains a milk similar to coconut milk. It is like an onion in shape and about 1½ inches in diameter. If cut across, about ¼ inch thickness of endosperm or solid "ivory" is revealed. It is estimated that under the local conditions about 180,000 fruits per square mile could be obtained or a weight of ivory of 8,000 lb. Its present use is mainly for curio carving, but the author is of opinion that it forms a promising substitute for animal ivory or bone for the manufacture of small articles, or even as a substitute for copra.—(*Horticultural Abstracts*, Vol. III, No. 2, Ab. 247.)

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

The Sugar Industry.

The prospects for the 1933-34 sugar crop are not as favourable as they were at the corresponding period last year. In Antigua and St. Kitts the distribution of the rainfall has not been so good and there was a definite shortage of rain during the months of September and October. In both islands the months of November proved more seasonable. The prospects for the 1933-34 crop in Barbados are however excellent, ample rains having fallen throughout the wet season. In Trinidad, the excessive rainfall has retarded growth considerably. In St. Lucia, prospects were excellent up to the end of October but damage was caused by very heavy rain storms experienced during the month of November.

Following visits paid to the islands by Mr. P. E. Turner in September and November and by Dr. A. E. S. Mc Intosh earlier in the year, a comprehensive series of experiments have been outlined on various cultural, manurial and varietal problems, and these are in the process of being laid down by the local Agricultural Officers.

FIELD EXPERIMENTS ON SUGAR-CANE IN ST. KITTS.*

A new series of field experiments on sugar-cane is now being inaugurated in St. Kitts and Antigua. They are designed to obtain information with regard to the problems of these islands which most urgently need investigation, and which would repay immediate examination. The experimental scheme for St. Kitts has recently been published and a brief outline of the investigations in progress is given below. The corresponding scheme for Antigua will be summarized in due course.

CULTIVATION AND MANURIAL EXPERIMENTS.

The St. Kitts' programme covers wide ground. It embraces the following eight types of cultivation and manurial experiments on plant canes and one precautionary soil experiment. A similar series of experiments on ratoon canes is to be drawn up in the near future.

I. Conservation of Moisture in the Dry Areas.—Use of Megasse as a Soil Mulch.

The Basse Terre Factory of St. Kitts has large quantities of surplus megasse. Arrangements have been made which enable this material to be generally available to the estates, and most of the estates have large quantities on order. The question therefore arises as to the manner in which the megasse can be most usefully employed. It may be put through the stock pens, and converted into pen manure, or it may be directly transported to the field and used as a mulch to conserve soil moisture. General experience indicates that the second alternative would lead to the greater financial gain. Critical experiments have therefore been devised to measure the value of megasse as a mulching agent and to determine the amount required to the acre for efficient moisture conservation. If mulching with megasse proves successful, stagnation in growth of the sugar-cane during the dry season may be minimised, earlier planting may be feasible and a greater and more efficient use of artificial manures may be possible.

II and III. The Supplementary Manurial Treatment of Pen-Manured Soils in the Wet and Dry Areas.

Plant canes in St. Kitts are customarily treated with 20 to 30 tons of pen manure to the acre, and 2 cwts. of sulphate of ammonia during the wet season of the following year. The pen manure is applied some distance from the roots of the plant, which is forced for some time to live on the residual fertility of the soil.

The experiments are designed to answer the following questions on both the *dry* and *wet* areas:

(*a*) What is the general effect on yield of dressings of sulphate of ammonia applied around the stool during the early stages of growth?

(*b*) If the general effect is favourable, what is the optimum dressing to apply?

(*c*) What is the most paying dose of sulphate of ammonia to apply during the second period of growth?

IV. Manurial Treatment of the "Upper" Lands.

Circumstances make it impossible as a rule to apply pen manure to the "Upper" lands which comprise roughly one quarter of the total acreage under sugar-canes in St. Kitts.

Experiments are being laid down to determine:

(*a*) The total dressing of sulphate of ammonia which gives rise to maximum net gain in the absence of pen manure.

(*b*) The proportion of the total dose which should be applied in the first and second dressings.

(*c*) Whether sugar-cane grown on the "upper lands" responds to treatment with potash, or whether there is at present a sufficient reserve of potash in the soil.

V. The Optimum Dose of Lime on Acid Soils.

In Trinidad it has been shown that greater financial gain results from applying half the lime requirement to heavy, acid soils rather than the full lime requirement. Similar experiments are being laid down on the light, acid soils of St. Kitts to determine what fraction of the lime requirement it pays best to add to the soil.

VI. Distance of Planting.

Critical studies are being made as to the optimum spacing in the row of plants grown in wet and dry areas.

*P. E. Turner (1933). "Report on Visit to St. Kitts". The Experimental Programme for Plant Canes. pp. 2-22.

VII. Preparatory Cultivation of the Soil.

In St. Kitts only the strips of soil between the old cane stools are ploughed. In consequence only about 50 per cent. of the total area of soil is worked to any appreciable depth. It is doubtful, therefore, whether the present practice is making full use of a wonderfully fertile soil. It seems possible that better results might be obtained by the introduction of close ploughing, especially as close ploughing has been adopted in almost every other cane-growing country. A comparison on an experimental scale of the two methods of preparatory cultivation is under way on the dry and wet areas of the island.

VIII. Molasses as a Manure.

Molasses contains large quantities of nitrogen and potash, and has been used as a manure with definite success in Mauritius, Java, Hawaii and Queensland. There is every reason to believe that it will give satisfactory results on soils of the type which obtain in St. Kitts. In the experiments the effect on yield of two rates of application of molasses is being measured against that of sulphate of ammonia, both alone and with potash.

IX. Precautionary Experiment.

It is possible that greater use will be made of sulphate of ammonia in St. Kitts in the near future. It was therefore considered advisable to obtain an estimate of the cumulative effect which continued doses of this manure might have on the light soils of the island. Very heavy dressings of sulphate of ammonia are to be applied in one experiment, and soil samples are to be taken from the various plots at intervals for analysis.

VARIETY TRIALS.

A number of variety trials based on the suggestions of Dr. A. E. S. McIntosh of the Department of Agriculture, Barbados, are also in operation. The varieties B.H. 10/12, B. 726, P.O.J. 2878 and B. 374 are being compared on the light soils and the stiffer soils of the wet areas. In the drier areas the varieties S.C. 12/4, B. 726, G. 119, B. 2935 and P.O.J. 2878 are under comparison in one series of experiments and the varieties B. 2935 and S.C. 12/4 in a second series.

The various experiments which have been outlined are all being laid down in the form of Latin Squares or Randomised Blocks. In the case of the cultivation and manurial trials, full costings data are being kept.

* * *

Central Cane Breeding Station, Barbados.

The second meeting of the Advisory Committee to the Central Cane Breeding Station, Barbados, was held early last November. It was attended by Mr. F. A. Stockdale, Adviser to the Secretary of State for the Colonies, Mr. R. W. R. Miller, Director of Agriculture, Barbados (*Chairman*), Mr. G. Evans, representing the Imperial College of Tropical Agriculture, Mr. G. A. Jones, Commissioner of Agriculture, the Windward and Leeward Islands, Dr. A. E. S. McIntosh (Geneticist, Department of Agriculture, Barbados), Mr. G. C. Stevenson (Assistant Botanist, Department of Agriculture, Barbados) and Mr. C. C. Skeete, Assistant Director of Agriculture, Barbados.

Some of the findings of the Committee are summarised below :—

Variety Trials.

The position of the various islands in regard to the conduct of variety trials in so far as it affects the type of seedlings to be issued from Barbados was discussed. It was recommended that the Geneticist and Assistant Botanist should visit the various trials as frequently as possible and that a sugar-cane survey of St. Lucia should be made at an early date.

A memorandum prepared by the Geneticist submitting recommendations in regard to sugar-cane variety trials in Trinidad, Antigua and St. Kitts was considered and approved. In these islands where the trials are carried out at the expenses of local planting associations, it was considered that additional varieties may also be included so long as the varieties recommended by the Geneticist are included in those trials. The value of growth recording was stressed. The attention of local agricultural officers was drawn in particular to the "memorandum on methods employed in carrying out sugar-cane variety trials in Barbados" prepared by the Barbados Department of Agriculture.

Gumming Disease.

Experiments in progress in Barbados were approved by the Committee. It was reported in this connection that the Trinidad Sugar-Cane Investigation Committee was desirous of importing new varieties for trial in Trinidad as soon as the Central Quarantine Station was ready to receive them.

Cane Breeding Problems for Conditions not found in Barbados.

The Geneticist explained that there were cane breeding problems for certain areas in Trinidad and Antigua (and possibly in Jamaica) where the conditions could not be exactly simulated in Barbados, and that therefore it would be necessary for more extensive preliminary work to be carried out in these islands and for which the local Department should assume responsibility.

Root System Studies.

Satisfaction was expressed with the work undertaken on root system studies which were explained in detail by the Assistant Botanist and the Geneticist.

Trinidad Quarantine Station.

The Principal of the Imperial College of Tropical Agriculture reported that the building of the Central Quarantine Station was almost completed and that it is anticipated that the Station will be able shortly to function. It was recommended that in future all importations of sugar-cane into the various islands of the British West Indies should be made through the Central Quarantine Station in Trinidad, and decided that all requests for sugar-cane importations will only be considered by the Central Quarantine Station when forwarded from the various Agricultural Departments of the British West Indies.

The Fruit and Vegetable Industry.

The past quarter under review, from September to November, does not cover the principal shipping season of any one crop. Shipments have consisted mainly of avocado pears to Bermuda and of citrus and bananas to Canada and the United Kingdom.

AVOCADO PEARS.

The total avocado pear shipments this year (5,607 crates to the end of October) will probably be around 1,000 crates less than in 1932, since November and December shipments will only total about 600 crates. This difference is largely accounted for by the fact that this year's season has been of shorter duration, only 415 crates being shipped in June and July as compared with 1,784 crates in the same period in 1932. Later season shipments from St. Lucia and Dominica were even larger than during the corresponding period last year. Shipments of avocado pears to the end of October, compared with those made in 1931 and 1932 are shown below. A noticeable feature is the relative increase of shipments from Dominica. The virtual withdrawal of St. Vincent from the trade is because competition with Dominica and St. Lucia is difficult since the voyage involved is on an average two days longer, and if anything local buying prices are apt to be somewhat higher.

Avocado Pear Shipments.
(Almost entirely to Bermuda)

	1931. crates.	1932. crates.	1933. (to end October) crates.
St. Lucia	2,718	4,742	2,898
Dominica	664	1,750	2,499
St. Vincent	381	840	116
Montserrat	2	161	94
Totals	3,765	7,493	5,607

From the experience of the past two years it would appear that under present conditions the Bermuda market can absorb to advantage around 6,500 crates of avocado pears per annum from these islands. Factors such as the increased use by retailers of their own cold storages, thereby enabling them to sell pears up to a week after the arrival of a shipment, all help to increase the possible remunerative maximum which is, as shown above, also subject to some variation with the length of the cropping season.

Exports of avocado pears to Canada and the United Kingdom have been practically discontinued, principally because the average West Indian seedling fruits do not stand up to the longer storage period involved (showing internal blackening, &c.), and in any case they ripen too fast and break down too quickly on removal from cold storage. It is hoped that some of the recently imported Florida varieties will in due course solve this problem. If a variety suitable to West Indian conditions could be obtained which would break down slowly on ripening the Bermuda trade could also be increased.

CITRUS.

Citrus shipments from Dominica have recently been going forward in relatively large quantities and have to date yielded satisfactory returns. Dominica shipped 2,137 crates and St. Lucia 236 crates of oranges during the period July to October (as compared with 709 and 166 respectively in 1932), these shipments being divided about equally between Bermuda and Canada. Grapefruit shipments also started earlier, and from August to October Dominica shipped 3,027 crates, mostly to Canada, as compared with 951 crates in 1932. These increased early shipments are largely due to a bloom obtained early in the year in addition to the main March-April bloom, and in districts where the dry season is not intensive it should be possible to increase this crop which matures when the market is relatively bare. As stated in the last *Quarterly Notes* an increase in the Dominica crop from 7,000 crates (1932) to about 10,000 crates is anticipated.

BANANAS.

Small shipments of bananas continue to go forward regularly, and since the quantities shipped per boat have been reduced the fruit has been out-turning in fairly satisfactory condition. Shipments during 1933 to the end of October have been as follows:—

	To Canada. (bunches)	To United Kingdom. (bunches)
St. Lucia	14,027	2,716
Dominica	4,654	8,699
Montserrat	626	—

Grenada has also shipped a few thousand bunches. It is understood that each of the Canadian National Steamships operating the Eastern Service will soon be fitted with an additional 30,000 cu-ft. of cold storage space under the cold air draught system and this development will permit the successful shipment of larger quantities. Grenada has recently formed a Banana Growers' Association and it is hoped that similar Associations will be formed in the near future in the other islands interested, in order to obtain more concerted action with regard to shipments.

OTHER PRODUCE.

With the closing season, shipments of mangoes after the end of August were negligible. Shipments of green limes have also been small and the recent further drop in the American exchange has naturally affected sales considerably.

During the past year there has been an appreciable increase in the trade in dry coconuts. This is well illustrated by the following figures of St. Lucia exports :—

To	1931.	1932.	1933. (approx. to end October)
	No. of nuts	No. of nuts	No. of nuts
United Kingdom	6,180	286,704	408,200
U.S.A.	95,890	34,844	238,260
Canada	29,920	20,600	88,220

Sea Island Cotton.

A Conference of West Indian Sea Island cotton growers was held at the Imperial College during the month of November, 1933, which representatives from all the cotton growing islands attended. The Report of this Conference has been published. As a result of the Conference a West Indian Sea Island Cotton Association has been formed and will in future be responsible for promoting and protecting the Sea Island cotton industry in the British West Indies. It will meet periodically to consider and take action on questions affecting the industry and for collecting and disseminating information.

After the Association was formed the delegates proceeded to examine the present position of the industry and made certain recommendations for the future. A policy of crop restriction has been followed during the last two years which has had a favourable effect in reducing the stocks of unsold Sea Island cotton. At the time of the Barbados Cotton Conference in 1932, the amount of unsold cotton was given as 2,733,000 lb. whereas at the end of October, 1933, the quantity unsold was only 1,005,000 lb. By controlling production during 1934-35 to an area which is estimated to produce about 780,000 lb. lint a further reduction in stocks is anticipated. The Association is in possession of information which indicates that much of the cotton which has recently changed hands has not gone into actual consumption.

Realizing that limiting production is not the final solution to the problem the Association proceeded to outline the work to be carried out in developing new uses and new markets for Sea Island cotton products. It was agreed to levy a cess on all cotton exports to cover the cost of conducting such enquiries. The delegates further decided to ask the Colonial Office to undertake the formation of an Advisory Committee in England to superintend and advise on the work of the Association in the United Kingdom.

The Commissioner of Agriculture has been appointed President and the Assistant to the Commissioner, Secretary and Treasurer of the new Association.

MISCELLANEOUS NEWS.

Mr. E. Taylor, Officer-in-Charge, Government Marketing Depot, Dominica, returned from vacation leave in September.

* * *

Mr. A. K. Briant, Assistant to the Commissioner, paid visits to Antigua, St. Kitts and St. Lucia during November and December.

* * *

Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua, returned from vacation leave spent in England on 23rd October.

* * *

The Commissioner of Agriculture sailed on an official visit to St. Vincent by the *Lady Nelson* on 4th December returning to Trinidad by the *Lady Hawkins* on the 9th.

* * *

Mr. R. A. Kitching, Agricultural Officer, Dominica, who was seconded to British Honduras for one year, has been appointed on the permanent establishment of that Colony.

* * *

Mr. G. A. Jones, Commissioner of Agriculture attended the Inter-Colonial Fruit Conference held in Jamaica during October as representative of the Imperial College of Tropical Agriculture and of the Governments of the Windward and Leeward Islands. Mr. A. C. Shill, Marketing Officer, who represented the Windward and Leeward Islands proceeded to Jamaica *via* Bermuda and returned to St. Lucia after an absence of two months, *via* Trinidad.

Mr. H. B. Pidduck, Agricultural Officer, Northern District, Dominica, arrived in Trinidad on 3rd October to take a refresher course at the College, returning on 14th December.

* * *

Mr. P. E. Turner, Adviser in Sugar-Cane Experiments to the Commissioner of Agriculture, visited St. Kitts in September and Antigua in November. During these visits Mr. Turner was accompanied in St. Kitts by the Commissioner of Agriculture, and in Antigua by the Assistant to the Commissioner.

* * *

Mr. Louis de Verteuil a former student and holder of the Diploma of the Imperial College has been selected to the vacant post of Agricultural Assistant in Antigua. Mr. de Verteuil has been employed in connection with a survey of the cane farming industry in Trinidad since he left the College in 1932.

* * *

At the West Indian Sea Island Cotton Conference which was held at the Imperial College of Tropical Agriculture during the first week in November Mr. G. A. Jones, Commissioner of Agriculture, was appointed first President of the newly formed West Indian Sea Island Cotton Association. Some of the meetings of this Conference were attended by Mr. F. A. Stockdale, Agricultural Adviser to the Secretary of State and by Mr. G. Evans, Principal of the College. Messrs. A. C. Shill and A. K. Briant acted as joint Secretaries of the Conference.

REVIEWS.

Spices and Condiments.

By H. S. Redgrove, B.Sc., F.I.C. *Sir Isaac Pitman and Sons, Ltd.*, London, 1933. pp. 384, price 15s.

Foods and flavourings are of universal interest to mankind, and the trade in spices and condiments is a very old one intimately linked with the history of both European and more ancient civilisations. The demand for spices was in part responsible for the opening of overland routes connecting Europe and the Far East. The trade probably reached its zenith during the middle ages. To-day, the quantities consumed and the variety of materials available are certainly greater, but with better facilities for transport and more efficient means of manufacture, market prices are relatively much lower. The literature on the subject is voluminous but rather inaccessible, as the information is scattered through an endless number of books on such divergent sciences as Agriculture, Chemistry, Botany, Pharmacology, and even Cookery. In this publication on spices and condiments, the author has managed to collect a fund of information which has never before been available in a single volume.

No exact definition of a spice or condiment can be given, and Mr. Redgrove has successfully circumvented this difficulty by adopting a very wide interpretation of his title, so that his book is singularly complete. The spices are grouped into chapters according to the part of the plant—roots, bark, flowers, &c.—from which the manufactured product comes. Both botanical and general indexes are given; these are thorough and make it very easy to locate the pages describing any particular spice. The author points out that it is not feasible to include a full bibliography of all the references that have been used in compiling the book. He has consequently given only an abridged and selected list. This is arranged by authors; a similar list classified according to subject matter might have been added with advantage.

The description of each spice or condiment includes the history, origin, varieties, cultivation, manufacture, chemistry and uses. The book is written primarily for food manufacturers, grocers, and others chiefly interested in the final product, so that the paragraphs dealing with the cultivation and varieties are, of necessity, very curtailed. Even here, however, the salient features have been selected with particular success, so that the book forms a very useful reference to all those interested in spices or condiments, whether in the raw product or the manufactured article. As the bulk of the spice producing countries lies within the British Empire, this volume should be given a place in the libraries of the administrative or research staffs in all the British colonies, and, in particular, in those within the tropical zone.

D. D. P.

On the Mineralogy of Sedimentary Rocks.

By Dr. P. G. H. Boswell. *T. Murby & Co.*, London, 1933. Price 21s., pp. 393.

Dr. Boswell (Professor of Geology in the Imperial College of Science and Technology, University of London) is an authority on the petrography of sediments, and has provided, in this book, valuable summaries dealing with various aspects of the subject, such as minerals as clues to the sources of sediments, geological correlation by means of minerals, the mineral composition of clays, &c. The greater part of the book (235 pages) is devoted to the bibliography of the subject, and consists of short abstracts of over one thousand papers published in many languages and in different scientific journals.

The usefulness of mineral analysis of sediments, and of soils derived from them, is likely to be demonstrated much more thoroughly in future years in relation to the determination of the agricultural value of soils, particularly in the tropics. Thus, Dr. Vageler, a recent writer on tropical soils, lays great stress on the part played by fresh minerals in deciding the degree of permanence of soil fertility in humid tropical regions (*see* Review, '*Tropical Agriculture*', X, 7, July, 1933, p. 197). To those investigators who may attempt to apply the methods of mineral examination to the evaluation of soils, Professor Boswell's book will come as a great boon, and its recent publication is indeed very timely.

F.H.

* * *

Notes on Plants and Plant Products with their Colloquial Names in 'Iraq Department of Agriculture.

By Evan Guest, A.R.C.S., B.Sc., A.I.C.T.A. '*Iraq Bull.* 27, *Govt. Print. Press, Baghdad*, August, 1933, pp. III+x, 1 map. To be obtained from the Agric. Direct., Baghdad. No price.

This publication is one of the most important which has been published by the Department of Agriculture in the 'Iraq during the 14 years of its civil existence. It was prepared by the author as a result of four years' assiduously prosecuted collecting and is the first comprehensive account of the flora of the 'Iraq. Professor von Handel-Mazzetti and others have investigated the flora of parts of Northern 'Iraq but no one has hitherto published an account of a botanical survey of the whole country. Short notes of a non-technical character are given of each important species, more especially about those of economic importance. In all, 735 species are listed, the uses of which are recorded when known.

The Bulletin is arranged alphabetically, the description of each species being found under the scientific name of the genus. The usefulness of the Bulletin is greatly enhanced by the inclusion

of the Arabic, Kurdish and English equivalents, if existent, in the one alphabetical list; while against each colloquial name is given the cross-reference to the scientific name. Thus, if the name of a plant is known, be it in English, Arabic, Kurdish, or Latin, it is easy to locate the plant description.

The question of the transliteration of Arabic words into English has been a difficult one and the source of much discussion amongst the exponents of rival systems. The system employed in the Bulletin is good, simple, and, on the whole, difficult to improve upon. 'Iraqui agriculturists should be grateful to Mr. Guest and Kew for giving them in handy form a summary of all that is known up to date of what the 'Iraq actually does grow, and for suggestions about plants which are worth trying.

H. V. W. DOWSON.

* * *

A NEW CENTRE OF CITRUS RESEARCH.

The publication of the first Report* of the Mazoe Citrus Experimental Station under the auspices of the British South Africa Company comes as a welcome sign at a time when resources for research are being curtailed rather than expanded. Dr. W. J. Hall, D.Sc. (Lond.), A.R.C.S., F.E.S., in his report as Director of the station traces its history up to the time of its official inception in April, 1931, and goes on to outline its present and future policy of research in the various departments. The staff of six, including a chemist, plant pathologist, horticulturist, and two entomologists (of whom the Director is one), is directly responsible to the British South Africa Company in whose interests the work is primarily carried out. The Company owns about 50 per cent. of the citrus crop of Southern Rhodesia—Mazoe Estate being their most important holding in that country—and the establishment of such a station forms part of their progressive policy of commercial citrus growing, and of their campaign against pests and diseases. The research station was, in fact, the immediate outcome of two serious pest attacks on their orchards—one of thrips in 1925 and one of aphis in 1926, when the need for scientific research into local problems became insistent. In brief, "the activities of this station are directed to the welfare of the trees on the Company's estates both now and in the future." With such wealth of experimental material at their disposal, opportunities seldom realised in other institutions of the kind are available both for immediate problems and for long-term research of wider application.

The Report covers the initial period between 1st April, 1931 and 31st December, 1932, and indicates the essentially practical nature of the problems under survey. The Entomological Section is making detailed study of the major pests—in particular Citrus Thrips, Red and Soft Scales, Citrus Aphis, and the False Codling Moth. Control measures against thrips have already been perfected and form the subject matter of Pub. No. 1 of the station. The Chemical Section is dealing with a diversity of problems, and in addition to completing a soil reconnaissance of Mazoe Estate studies in particular aspects of manuring, irrigation, cover crops, and certain physiological diseases are receiving its attention. Transport and storage problems, including work on artificial coloration of fruits by ethylene gas, have been prosecuted by the plant pathologist, whilst to the horticulturist falls the task of maintaining the experimental orchard, nursery work, variety testing both for stocks and fruit quality, and other related aspects.

It would be outside the scope of this note to make more than the briefest mention of the original articles submitted in the body of this Report. The titles include: I.—"Notes on some Citrus insects of Southern Rhodesia," W. J. Hall and W. K. Ford; II.—"Preliminary investigations into soil conditions and observations on Field Practices on Mazoe Estate," A. A. Morris; III.—"The Development of Artificial Coloration of Oranges in Southern Rhodesia and its relation to Wastage," G. R. Bates; IV.—"Wastage during the 1932 Export Season," G. R. Bates; V.—"Maturity Test Data 1932," G. R. Bates. Contributions from the Horticultural Section will doubtless be forthcoming in later issues, but data of that nature, in a crop which under Rhodesian conditions takes seven years to come into bearing, must of necessity be slow to accumulate.

The station plans to issue Reports annually in the future, and if the present high standard is maintained the Mazoe Citrus Experimental Station will be making a real contribution to citrus literature.

N. W.

* Mazoe Citrus Experimental Station. Report for period ending 31st December, 1932. Publication No. 2, 1933. (*University Press*, Oxford.) Copies obtainable from the Secretary, the British South Africa Company, 2, London Wall Buildings, London, E.C.2, or the Director, Mazoe Experimental Station, Mazoe, Southern Rhodesia.

* * *

ANNUAL REPORTS OF THE DEPARTMENTS OF AGRICULTURE, WINDWARD AND LEEWARD ISLANDS.

With the publication of the Annual Report of the Agricultural Department, Dominica, in October the island series is now complete for the year 1932. These reports should be read by all those interested in the agricultural development of the islands concerned. Reports from the Cotton Research Officer stationed in St. Vincent covering the period August, 1930 to August, 1933, have been received. It will be recalled that the Empire Cotton Growing Corporation agreed to re-open the station in St. Vincent in 1930 and since that time Mr. S. H. Evelyn, working under the direction of Dr. Harland, has been engaged in improving the strain of cotton known as V. 135 which is now exclusively planted in St. Vincent. The report details other important work undertaken at this station and will, it is hoped, be made available by the Corporation.

G. A. J.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Cane Purchase and Sugar Distribution: Factors influencing the Java Ratio (1). *R. H. King.*

The author has plotted values of the Java Ratio and the polarization of the crusher juice for three representative Philippine centrals in order to see whether there was a relationship, and found considerable variations. In one central the Ratio declined as the polarization increased while in the other it increased. A few tenths increase in the polarization of the crusher juice, at times, resulted in more than a seven-point variation in the Java Ratio.

Similarly he has studied the effect of the fibre content of the cane on this value, plotting weekly average data for three Philippine centrals, and finding the Ratio to vary from around 77 to 83, while the fibre remained practically constant. In the case of Mill A the Ratio varied from 80.3 to nearly 85 while the fibre in the cane increased only a few tenths. Variations in the Ratio were also observed when the normal juice factor and the juice extraction remained constant or practically so.

A proposed simplification of the distribution is based on the analysis of each planter's juice and the average composited crusher juice for the period under distribution—say 24 hours. This scheme would be independent of the Java Ratio, the extraction, the purity of the mixed juice, and such data.

All that would be required would be gravity purity determinations of the final molasses produced during the period and the total tons of sugar made and the tons of available sugar in stock together with the true purity of the sugar.

By multiplying the Brix and pol. of the planter's juice by his tons of cane and multiplying the the average composited crusher juice by the tons of cane ground for the period, the tons polarization due each planter and the tons polarization entering the crusher juice will be obtained. By using the S-J-M relationship with the average purity of the crusher juice, the gravity purity of the final molasses, together with the purity of sugar made, the total tons of sugar entering in the crusher juice could be calculated. This figure could be called the expected yield. A similar calculation using the tons polarization and purity of the individual planter's juice would give the expected yield due the planter.

By dividing the tons due the planter by the tons expected from all of the crusher juice, a percentage would be given by which the actual sugar bagged during the period plus the amount in stock due the period could be multiplied. The expected recovery based upon the purity of the crusher juice would be higher than that actually obtained. The chemist would have a daily check on his sampling as the sum of the polarization due each planter must equal the tons polarization entering in the composited crusher juice. Such a scheme would eliminate approximations of undetermined losses, approximations of Java Ratios and extractions, and would divorce the distribution from the control.—(*Inter. Sugar Journ.*, Vol. XXXV, No. 418, 1933.)

(1) *Inter. Sugar Journ.* 1933, p. 279.

* * *

Use of a 26.026 Grm. Normal Weight for Ventzke Scale Saccharimeters.—*C. A. Browne and R. T. Balch.*

The recognition of a long-established error of 0.1° in the 100° point of Ventzke scale saccharimeters by the International Commission for Uniform Methods of Sugar Analysis at its eighth session, held at Amsterdam, September 5th to 8th, 1932, was most fortunate in removing the uncertainties which had prevailed among the users of Ventzke scale saccharimeters in all parts of the world.

Among the recommendations of the commission, adopted at the Amsterdam meeting, is the following: "In the case of existing instruments graduated on the Herzfeld-Schonrock scale (*i.e.*, Ventzke scale) it shall be permitted either to change the saccharimeter scale or to use a weight of 26.026 grms. in 100 ml."

The old Mohr c.c. normal weight for Ventzke scale saccharimeters was 26.048 grms. and some users of saccharimeters still employ this old standard. In order to avoid the error which might result from the mistaken use of the old Mohr c.c. normal weight in place of the metric c.c. normal weight of 26.000 grms., which was adopted by the Commission at its Paris meeting in 1900, manufacturers of weights adopted a cubical form for the metric c.c., or ml., weight which could be readily distinguished from the old cylindrical Mohr c.c. weight.

In view of the alternative suggestion of the Commission to employ a new weight of 26.026 grms. for correcting the error of the old Ventzke scale, it would seem desirable that such weights should have a shape that is readily distinguishable from the older forms. The writers have accordingly had constructed hexagonal weights of brass for the new normal and half-normal values of 26.026 and 13.013 grms., respectively. As an additional protection against confusion, the new weights have their numerical value in grms. stamped upon the upper surface. The stems of the weights can be unscrewed if it is desired to correct any slight loss from abrasion by the insertion of a small thread of wire in the interior cavity.

This method of correcting the error of the old Ventzke scale necessitates no change in the instrument and is much cheaper and fully as accurate as to equip saccharimeters with special new scales which would correspond with the former normal weight of 26.000 grms. By supplying new weights, manufacturers will render a much needed service to the many thousands of chemists who are using saccharimeters of the old Ventzke scale type.—(*Inter. Sugar Journ.*, Vol. XXXV, No. 417, 1933.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Manurial Experiments on Coconuts and Oil Palms.

—W. N. C. BELGRAVE AND J. LAMBOURNE.

The layout of the experiment on coconuts consisted of four experimental blocks of 64 palms divided each into four plots of 16 palms on each of seven coconut estates. Each of the four plots of 16 palms is again subdivided into four tree plots to which are applied (*a*) complete NPK; (*b*) lime; (*c*) lime and NPK; (*d*) nothing. The plots are safeguarded by drains and guard rows. Results from statistical analysis for 1932 show that after two years no manurial increase is significant, but that clean weeding shows a definitely better result over other cultivation treatments (cover crop, grass, or slashing of cover) on Estate B, is better than slashing on Estate D and just misses significance on Estate F. The chief feature of the experiment has been the improvement of yield due to cultivation on Estate B.

The experiments on oil palms on two estates and at the Government Experiment Station, Serdang, show, when statistically analysed, that gains resulted from manuring with phosphate manures on estates A and B, while no further increases resulted from the addition of potash, nitrogen or magnesia. It is recommended that manuring should be carried out on organic or on quartzite hill soil or on areas yielding less than 1,300 lb. of oil per acre at 10 to 12 years; on other soils and in higher yielding areas preliminary experiments should be made before incurring the expense of manures.—(*Imperial Agricultural Bureaux, Hort. Abs.*, Vol. III, No. 3, Ab. 408.)

* * *

Sugar-Cane Manurial Experiments in South Africa.

The Sixth Annual Congress of the South African Sugar Technologists' Association held in Durban produced some very interesting papers on sugar-cane manuring. An abstract of one of these, entitled "A Report on a Fertiliser Experiment at the Milkwood Kraal Section of Natal Estates, Ltd." is given below. It indicates the deficiency of certain Natal soils in phosphate. The site of the experiment was a heavy dark loam over a clay and shale subsoil. Ten combinations of the three manures, Superphosphate, Chloride of Potash and Sulphate of Ammonia, were applied, with five repetitions giving, with the controls, 55 plots. The records of the results both of the field and of analyses of the juice are given in great detail. Unfortunately the expected irrigation was not available during the first year and the cane suffered from drought during this period. Too much reliance cannot, therefore, be placed on the results, but the main indications are as follows. The main fertiliser required by this soil is phosphorus, and the use of superphosphate is very profitable. Probably dressings heavier than 960 lb. per acre, the heaviest applied, could be profitably used. This beneficial effect was to some extent masked by the depressing effect on yield of ammonium sulphate. No response is shown to potassium chloride. Sulphate of ammonia had a further depressing effect on purity and the double effect of this fertiliser may be due to the fact that the land had not been cultivated for a long time and had been more or less under wattle.—(*Inter. Sugar Journ.*, Vol. XXXIV, No. 404, p. 295.)

* * *

Preservation of Orange and Grapefruit Juice.

In experiments on the de-aeration and flash pasteurisation of orange and grapefruit juices, carried out at the U.S. Citrus Products Laboratory, Winter Haven, Florida, juice was prepared by reaming the cut halves of fruit on a fast revolving burr. Juice and pulp were fed direct from reamer to a slow revolving screen, and separated, the juice draining into a small receiver, and thence being drawn by vacuum into the de-aeration apparatus. Here the juice was forced at high velocity through a small nozzle against the dome-shaped base of an inverted flask, where it formed a thin film containing numerous bubbles. Temperature of juice was adjusted to just below boiling point at the vacuum used (usually 25 ins.). Under these conditions the small air bubbles expanded and burst. Formation of bubbles impeded flow down side of the flask, liquid being thereby exposed for a short time to effect of vacuum in the form of a thin film.

Half-a-minute's reaming produced enough screened juice to start de-aeration. Hence contact of juice with air was limited to half-a-minute. It would seem that this period would not be greatly increased in commercial practice.

The liquid was circulated through the pasteurising apparatus by pumping, the use of pressure by inert gas being thus dispensed with. The pasteurising apparatus consisted of a block tin tube, flattened into a ribbon so that the cross section became an elongated ellipse, formed into a coil and placed in a steam jacket. Time of exposure to heat was reduced to five seconds. The juice was then led from the pasteurising apparatus through a tube of similar construction immersed in cold water which cooled the juice to about 170°F. It was then run into glass or tin containers, which were closed and immediately placed in cooling water. Besides sanitary cans, four-ounce crown-finish flint glass bottles were used, the tin spot crown closures being sterilized by connecting the carbonated water inlet of a bottling machine with a steam line. Steam was thus forced under the crown for the few seconds while the bottle was in the crowning position, thereby reducing the amount of air in the head-space of the bottle. Excellent flavour is reported after four months' storage of grapefruit juice and from one to six months' storage of orange juice. Further work is necessary to get assurance of uniform results for commercial application.—(*Fruit Products Journal* (New York), July, 1933. *Food*, October, 1933, p. 36.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
26th October	5	0¾	9	9¾
2nd November	4	11¼	9	9
9th November	5	1½	9	6
16th November	5	1½	9	0
23rd November	5	1½	9	3
30th November	4	7½	9	4½
7th December	4	7½	9	3
14th December	4	7½	9	3
(*8th Dec.*, 1932)	5	5¼	10	3

Conditions on the market have mainly been dull with quotations about unchanged to slightly easier. While the present situation is to some extent attributed to fluctuations in the dollar sterling rate it is also influenced by the existing technical position of the markets. In America, according to *C. Czarnikow Ltd.*, refiners appear to be more comfortably supplied with raw material than was earlier believed, and continue to hold aloof from the market. The arrival moreover in U.K. of Empire sugars during the next two months or so, at a time when home grown sugars are available in considerable quantities, tends to create some congestion in the U.K. supply situation and to narrow, for a time, the outlet in the World's open markets.

* * *

COFFEE.—The market is generally quiet, the demand for spot coffees being disappointing mainly in view of the unattractiveness of the offerings. Latest quotations include Costa Rica (new crop) 94*s.* 6*d.*, 102*s.* 6*d.* superior Santos 35*s.*, bold Kenyas 129*s.* 6*d.*

* * *

COCOA.—Markets generally have been affected by a recent French Government decree restricting the importation of cocoa from the Ivory Coast by 50 per cent. or approximately 30,000 tons. Exporters selling and shipping this quantity outside of France are granted Export Certificates which enables them to export to France an equivalent amount free of duty. Failing Export Certificates cocoa entering France from the Ivory Coast is to pay a duty of 90 Frs. per 100 kilos. This has meant that Ivory Coast Cocoa has for the time being, been a competitor with Accra and Lagos and with a weak market prevailing prices for the latter grades have reached to the record low figure of 16*s.* 6*d.* Many theories are advanced as to why the French Government have found it necessary to take this action and one is that in order to help balance their budget they are in need of heavy sums in foreign exchange to meet their obligations. Locally $4.60 a fanega is generally paid for Plantation Cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
25th October	3 7-8
1st November	3 29-32
8th November	3 31-32
15th November	4 1-8
22nd November	4 1-8
29th November	4 3-16
6th December	4 11-32
13th December	4 3-16
(*7th Dec.*, 1932)	2 9-16

Prices have been steady to firm on bullish rumours concerning the progress of restriction negotiations. Developments in America continue to constitute the chief influence in world markets, the point of general interest being President Roosevelt's final intentions regarding currency. Heavy shipments of rubber have been made in the meantime to U.S.A. by importers fearing a depreciation in the value of the dollar. The consumption figure for October at 32,000 tons is about what had been expected.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
27th October	5.54	7.06
3rd November	5.43	7.26
10th November	5.31	7.10
17th November	5.13	6.93
24th November	5.09	7.01
1st December	5.14	—
8th December	5.21	—
15th December	5.32	—
(*9th Dec.*, 1932.)	5.04	6.77

Prices have generally shown a somewhat easier tendency while future business continues to be limited. American money developments and their effect upon rates of exchange have been the principal factors affecting the trend of the market. No business is reported for West Indian Sea Island.

* * *

BANANAS.—There has been a slight falling off in the demand for Jamaicas, but the prices per ton to wholesalers have been maintained at :—

	Delivered London.	*Provinces nearest Station.*
Jamaica Producers	£21 5	£21 0
Elders & Fyffes	£22 5	£22 0

Brazilians have been in fair demand at the unchanged price of £19 per ton delivered nearest station.—(*West India Committee Circular*, 23rd November, 1933.)